Hobby Electronics

November 78

40p

Component Codes
What the colours mean

DIY Stereo Amplifier
Full constructional details

Bedside Radio Project
Music for insomniacs

Home Computers
What are they?

Metal Locators
Discover how they work

Understanding Hi-Fi Specs.
We take the lid off

Into Electronics
A series for newcomers

DIY Digital Clock
Time well spent

OSTS "One Stop Technology Shopping" now from ambit international ®

Ambit stoppress....news on items available.....KV1210: triple AM tuning diode with 2-9v bias only £2.75.....DTI200 Digital frequency readout module ...... 911223 ultra low THD/IMD mpx decoder module £9.95.......944378 'Hyperfi' mpx decoder with post decoder muting and pilot cancel £19.95...... VMOS

COUNTER ATTRACTIONS:

New this month from Intersil, the ICM 7216. This is probably the most significant new IC for frequency counter/timer applications ever devised. It drives a full 8 digit display (LED) and operates on inputs of up to 10MHz minimum. The single 28 pin DIL also has:- •Leading zero blanking •Frequency ratio •Period •Unit counter •Time Interval •overrange The IC cost is £19.82, and the 10MHz HC18U Xtal £2.50 (for timebase functions). The circuit data is free with the IC, or £1 purchased separately. Input preamp board £7.00.

New from Ambit is the MC3357. 6v, 2mA standby NBFM IF, detector and squelch with 10.7 - 455 kHz balanced mixer, onboard oscillator device, and 5uV sensitivity. It is ideally suited to our CFM and LFY filter series, and costs £3.12 with full data. Xtal £2.50.

*Please note that OSTS prices exclude VAT at 8% throughout this side of the page. Most ambit items are at 12½% except those marked *. Please keep orders separately totalled, although a single combined payment, and 25p postage charge, will be sufficient.*

CD4000 CMOS

4000	17p	4059	563p	4522	149p
4001	17p	4060	115p	4527	157p
4002	17p	4063	109p	4528	102p
4006	109p	4066	53p	4529	141p
4007	18p	4067	400p	4530	90p
4008	80p	4068	25p	4531	141p
4009	58p	4069	20p	4532	125p
4010	58p	4070	20p	4534	614p
4011	17p	4071	20p	4536	380p
4012	17p	4072	20p	4538	150p
4013	55p	4073	20p	4539	110p
4016	52p	4075	20p	4541	141p
4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
4019	60p	4078	20p	4553	440p
4020	93p	4081	20p	4554	153p
4021	82p	4082	20p	4556	77p
4022	90p	4085	82p	4557	386p
4023	17p	4086	82p	4558	117p
4024	76p	4089	150p	4559	388p
4025	17p	4093	50p	4560	218p
4026	180p	4094	190p	4561	65p
4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	281p
4030	58p	4099	122p	4569	303p
4031	250p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	100p
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	69p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	248p		
4044	80p	4510	99p		
4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
4050	55p	4516	125p		
4051	65p	4517	382p		
4052	65p	4518	103p		
4053	65p	4519	57p		
4054	120p	4520	109p		
4055	135p	4521	236p		

Micromarket — PRICES SLASHED

6800 series					
6800P	6.50	8216	1.95	2114	£10
6820P	£6	8224	3.50	2708	£10.55
6850P	2.75	8228	4.78	Development	
6810P	£4	8251	6.25	MEK6800	£220
6852	3.65	8255	5.40	TK80	£306
8080 series		MEMORIES		AMI, Signetics, TI, Intersil, Harris etc. OA	
8080	6.30	2102	£1.70		
8212	2.30	2112	£3.40		
		2513	£7.54		
		4027	£5.78		

Voltage Regs

NEW LOW PRICES

7800 series UC TO220 package 1A	all 95p
7900 series UC TO220 package 1A	all £1
78MUC series TO220 package ½A	all 90p
78LCP series TO92 100mA	all 35p
L200 up to 3A/adjustable V&A	195p
78MGT2C ½amp adjustable volts	175p
79MGT2C ½amp adjustable volts	175p
723C precision controller	65p

MAINS FILTERS FOR NOISE/RFI etc

1 amp in IEC connector	£4.83
5 amp in 'wire in' case	£3.87
NE550A	73p

LINEARS non-consumer

BIMOS			
CA3130E	84p	LM324N	71p
CA3130T	90p	LM339N	66p
CA3140E	35p	LM348N	186p
CA3140T	72p	LM3900N	60p
CA3160E	90p	709HC to5	64p
CA3160T	99p	709PC dil	36p
Op amps		710HC to5	65p
LM301AH	67p	710PC dil	59p
LM301AN	30p	723CN	65p
LM308H	121p	741CH to5	65p
LM308N	97p	741CN 8dil	27p
LM318H	279p	747CN	70p
LM318N	224p	748CN	36p
		NE531T	120p
		NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:

5082- 7650	red CA	233p
5082- 7653	red CC	
5082- 7660	yellow CA	
5082- 7663	yellow CC	
5082- 7670	green CA	
5082- 7673	green CC	

0.3" Standard HP

5082- 7730	red CA	147p
5082- 7740	red CC	

0.5" Fairchild

FND500	red CC	150p
FND507	red CA	150p

TLL: Standard AND LP SchottkY

All prices listed in pence *

	'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		'N'	'LSN'
7400	13	20	7455	35	24	74126	57	44	74185	134	
7401	13	20	7460	17		74128	74		74188	275	
7402	14	20	7463			74132	73	78	74190	115	92
7403	14	20	7470	28		74133		29	74191		
7404	14	24	7472	28		74136		40	74192	105	180
7405	18	26	7473	32		74138		60	74193	105	180
7406	38		7474	27	38	74139		60	74194	105	187
7407	38		7475	38	40	74141	56		74195	95	137
7408	17	24	7476	37		74142	265		74196	99	110
7409	17	24	7478			74143	312		74197	85	110
7410	15	24	7480	48		74144	312		74198	150	
7411	20	24	7481	86		74145	65		74199	160	
7412	17	24	7482	69		74147	175		74248		90
7413	30	52	7483A			74148	109		74251		90
7414	51	130	7484	97		74150	99		74253		105
7415		24	7485	104	99	74151	64	84	74257		108
7416	30		7486		40	74153	64	54	74279		52
7417	30		7489	205		74154	96		74283		120
7420	16	24	7490	33	90	74155	54	110	74290		90
7421	29	24	7491	76	110	74156	80	110	74295		120
7422	24	24	7492	38	78	74157	67	55	74298		100
7423	27		7493	32	99	74158		60	74258		110
7425	27		7494	78		74159	210		74260		26
7426	36	27	7495A	65	99	74160	82	130	74365		49
7427	27	29	7496	58	120	74161	92	78	74366		49
7428	35	32	7497	185		74162	92	130	74367		43
7430	17	24	74100	119		74163	92	78	74368		49
7432	25	24	74104	63		74164	104		74375		60
7433	40	32	74105	62		74165	105		74379		130
7437	40	24	74107	32	38	74166			74399		150
7438	33	24	74109	63	38	74167	20		74445		92
7440	17	24	74110	54		74168			74447		90
7441	74		74111	68		74169		200	74490		140
7442	70	99	74112	88		74170	230	200	74668		110
7443	115		74113		38	74172	625				
7444	112		74114		38	74173	170				
7445	94		74116	198		74174	87	120			
7446	94		74118	83		74175	87	110			
7447	82		74119	119		74176	75				
7448	56	99	74120	115		74177	78				
7449		99	74121	25		74180	85				
7450	17		74122	46		74181	165	350			
7451	17	24	74123	48		74182	160				
7453	17		74124			74183		210			
7454	17	24	74125	38	44	74184	135				

ICM7217 - count & display £9.50
ICM7207 - clock pulse IC £4.95
ICM7208 - count & display £14.95
ICL7106CP - LCD DVM IC £9.55
KIT... £24.80
LED DVM with ICL7107 £20.65

MISCELLENY

NE555	30p
NE556	78p
NE558	180p
LM3909	72p
11C90DC	1400p

8629 divide by 100 to 150MHz 4.20p
95H90DC 320MHz divide by ten 7.80p

Ambit overspill

the remainder of this column is not OSTS

Varicap diodes VAT 12.5%.......

BA102	30p
BA121	32p
ITT210	30p
BB105B	40p
BB104B	45p
6xBB104B	200p
MVAM2	148p
MVAM115	105p
MVAM125	105p
matching to a max of 6 diodes per diode (1%)	25p
KV1210	275p

PIN & switching VAT 12.5%.......

BA479 pin	35p
tda1061 pi-network attenuator	95p
BA182 bandswitch diode	21p
10 for	150p

Requests for the next issue of the catalogue now being "booked" for despatch immediately it is ready (about November). Please send 45p to reserve a copy.

From the World's leading radio innovation source:

Apart from the MC3357, mentioned alongside, Ambit has the first easy-to-use low noise, low cost UHF dual gate MOSFET - the BF960 from Siemens. With a gain of 18dB, and a noise figure of only 2,8dB at 800MHz, you will see what we mean. At 200 MHz, the gain is 23dB, and NF only 1.6dB. Combine these figures with the famous ease of use of a dual gate MOSFET, and you have the easiest and most effective front end device yet. £1.60 each

Moving Coil Meters

Ambit offers a very wide range of low cost meters, together with the unique 'Meter Made' scale system for professional grade scale customizing:

Series	Scale Area	Illumination	cost*
900	14x31mm	internal 12v	250p
920	30x50mm	from behind	275p
930	36x63mm	internal 12v	375p
940 twin	35x45mm	from behind	350p
950	55x45mm	from behind	300p

Stock movement 200uA/750Ω. The 930 series is 5% linear, others are 77uA at 50% FSD. These and many others available in quantity for OEMs *SAE for full scale details please. (Not in cat.)*

Radio; Audio; Comms ICs:

Only the very best quality - and only types we have used in our own laboratory tests

Radio frequency + mixers + oscillator(s)		
TDA1062	DC to VHF front end system	1.95
TDA1083/ULN2204	am/fm/audio in one IC	1.95
TDA1090/ULN2242	am/fm hifi tuner system	3.35
HA1197	LF/30MHz am receiver system	1.40
CA3123E/uA720	LF/30MHz linear system	1.40
TBA651	LF/30MHz linear system	1.81
SD6000	DMOS RF/Mixer pair	3.75
IF amplifiers		
CA3089E/KB4402	famous FM IF system	1.94
HA1137W/K	4420 as 3089 + deviation mute	2.20
CA3189E	update with deviation mute	2.75
TBA120a/SN76660N	FM if and detector	0.75
TBA120S	hi gain version TBA120	1.00
MC1350P	agc IF amp	1.20
MC1330P	synch AM demodulator	1.35
MC1495L	precision 4 quad multiplier	6.86*
MC1496P	popular double balanced mixer	1.25
Communications circuits		
KB4406	differential amplifier	0.50
KB4412	2 bal.mixers/agc/gain/doub. conv	2.55
KB4413	am/fm/ssb det. AGC, ANL, mute	2.75
KB4417	3mV mic processor preamp	2.55
KB4423	FM noise blanker system	2.55
Audio preamps		
LM381	stereo high gain/low THD	1.81
LM1303	stereo audio optimized OA	0.99
TDA1054	high quality with alc option	1.95
KB4417	see above	
Audio Power amps		
TBA810AS	7W RMS overload protected	1.09
TDA2002	8W/2Ω in pentawatt package	1.95
TDA2020	15W RMS hifi power dc coupled	2.99
TCA940	10W higher voltage 810	1.80
ULN2283	1W 2.5 to 12 v supply capability	1.00
LM380N8	1W power	1.00
LM380N14	2.5W power	1.00
HA1370	HiFi 15w in easy heatsink pack	2.99
Stereo Decoder Devices		
MC1310/KB4400	original pll decoder	2.20
CA3090AQ	RCA's pll decoder	3.25
uA758	Buffered version of 1310	2.20
LM1307/uA707	non pll type	1.55
HA1196	advanced adj.sep pll low thd	3.95
HA11223	newpilot cancel low thd/imd	4.35

All ambit decoders are supplied with the LED beacon of your choice. Please state colour.

Discrete semiconductors

Some of the biggest stocks of specialist MOS and FET transistors for radio in the UK.

BF900	80p*	40673	55p*	40822	43p*
40823	51p*	MEM680	75p*	BF256S	34p*

Most types for most RF circuitry, inc. new UHF T package types etc. See price list.....

Hitachi VMOS 100W power devices:

Hitachi 2SK134 /2SJ48 100W comp. VMOS. Data and circuit info £1, and the devices themselves for £14.00 a pair *

DISCRETE LEOs from Telefunken, square sided and round. AMBIT has the best value......

LED size (mm)	2.5x5	5 dia	2.5dia
RED	17p	14p	14p
Yellow	20p	15p	15p
Green	20p	16p	16p
Orange	24p /he	29p/he L	17p

he= high efficiency L= lens end

10% disc for 10
25% per 100 mix

Switch Systems: Check our combinations !

A very wide selection of BOTH Alps SUB series units, (Schadow/AB/Oreor compatible) & the miniature Dialistat units. Available in DIY systems for maximum flexibility and low cost.

And Finally

Further details of these, and many more of the wonders of the world of wireless in the new Ambit catalogue - with magazine supplement. 45p inc pp etc.
Phone (0277) 216029/227050 9am-7pm
callers welcome anytime

Coils & Filters by TOKO

After a period of relative price stability, please note that some prices are increased- as a direct result of the failure of £ versus stronger trading currencies. (Mainly Yen)

7 & 10mm IFTs for AM/FM - 1000s es	
455/470kHz most types of appcns	30p
10.7MHz	33p
Short Wave Coils sets	
Now two ranges of impedance/coupling ea	33p
TV video and sound IFs/detectors	
Another new range in 10mm	33p
6MHz ceramic IF sound filter	80p
Molded VHF coils full catalogue 15p	
Ultra stable coils for 30 - 200MHz from	20p
Chokes - biggest range/biggest stocks	
Most E12 values ex stock, any to order	
7BA series 1uH to 1mH	16p
8RB series 100uH to 33mH	19p
10RB series 33mH to 120mH	33p
FM IF FILTERS ceramic and linear phase	
CFSE/SFE10.7 stereo ceramic IF 10.7MHz filters in 5 groups	50p
CFSB10.7 mono/roofing IF filter	50p
BBR3125N 4pole linear pahe 10.7MHz	150p
BBR3132A 6pole linear phase 10.7MHz	250p
MPX pilot tone filters for 19 & 38kHz	
BLR3107N Stereo 4k7 impedance	215p
BLR2007 Stereo 3k3 impedance	220p
BLR3152 Mono 4k7 impedance	100p
BLR3157 Mono 4k7/3k0 imp	100p
AM/FM/SSB IF FILTERS	
MFL series 2.4kHz ssb /455kHz carrier	1195p
MFH series 4/5/7kHz BW on 455kHz	195p
MFK series 7/9kHz BW on 455kHz	165p
LFY455D 12kHz 4 ele ladder on 455kHz	125p
CFM2455 6kHz micro mechanical ..	65p
SFD455/470kHz murata IF filter	85p
CFT455B/C 6/8kHz min + 2IFTs	60p
CFU470C 6kHz on 470kHz	65p
Ratio Detectors for FM/NBFM	
1A661/7 455kHz ratio det	135p
KAN1508/9 10.7MHz ratio detector	66p
94ACS15106/7 10.7MHz ratio detector	66p
Quadrature detectors for CA3089E etc	
KACSK586HM single	33p
KACS34342/3 double	66p
Polyvaricon tuning capacitors + trimmers	
2A20ST7 2x266pF AM	95p
CY22217Z 2x335p AM 2x20pF FM	175p
CY23217PX 2x335pF AM 3x20pF FM (2 trimmers)	245p

Tuner Modules

From the biggest and best range..................

TUNERHEADS for 88-108MHz band 2 (varicap)		
EF5803	6 cct, 3 MOSFETs, amp. osc.	19.75
EF5801	6 cct, 2 MOSFETs, osc op	17.45
EF5600	5cct, MOSFET RF, by TOKO	14.95
EF5400	4cct balanced mixer/pin agc	9.75
EC3302	3cct FET input miniature	8.25
TUNERSETS by LARSHOLT (head+IF)		
7252	Dual MOS head/low dist IF	26.50
7253	FET head, mpx decoder inc	26.50
IF AMPLIFIERS all with deviation mute, agc, afc, meter drives etc		
7020	HiGain dual ceramic filter	6.95
7030	Mos preamp, linear phase filter	10.95
7130	2 mos preamps, 3 lpfilters	16.25
NBFM1	455/470kHz NBFM module	9.95
MPX decoders, all with pilot tone filters and buffer amplifiers for min 300mV RMS		
92310	1310 based system	6.95
93090	3090AQ based system	8.85
91196	HA1196 based + birdy filter	1299
91196B	HA1196 based + birdy filter + 2 x LM380 audio monitor amps	16.45
911223	HA11223 based system	12.50
AM RADIO -		
91197	The original MW/LW varicap tuner with electronic switch	11.85
9122	The uniband tuner module	13.22
AM FM RADIO UNITS		
71083	Using TDA1083, provides a complete MW/LW/FM portable radio chassis for clock radio etc	12.95
71083D	Drive/dial system for 71083	1.75

SPECIALS: TUNERHEADs in the range 40-200MHz to special order
The EF5803 and EF5400 are available to cover bands in the region described. The costs depend on quantity and actual mods required to cover the desired band. Max coverage approx. 20% of centre frequency selected. Also, please allow 3-5 weeks delivery for these items.

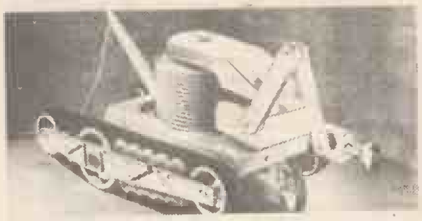
2 Gresham Road, Brentwood, Essex.

Hobby Electronics

Vol. 1. No. 1. November, 1978

A single PCB makes construction really easy

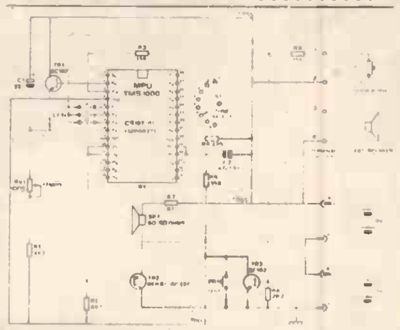
Using a readily available module, this should take no time at all



No longer just science Fiction

Add your own effects

Let Today in Parliament lull you to sleep



We've built and tested it

A mine of information

Hobby Electronics
25-27 Oxford Street, London W1R 1RF
01-434 1781
Published by Modmags Ltd,
Distributed by Argus Distribution Ltd,
Printed by Q.B. Ltd, Colchester
Hobby Electronics is normally published on the second Friday of the month prior to the cover date

Editor: Halvor Moorshead

Editorial Staff: Phil Cohen B.Sc, Jim Perry, Ron Harris B.Sc, Gary Evans, John Koblanski, Steve Ramsahadeo, Paul Edwards.

Advertising: Mark Strathern, David Sinfield, Tom Moloney.

Admin Staff: Margaret Hewitt, Andrew Scott, Bren Goodwin, Kim Hamlin, Val Tregidgo, Tim Salmon.

BUILD THE

TREASURE TRACER MK III

METAL LOCATOR

AS SEEN ON BBC-1 & BBC-2 TV

- Genuine 5 silicon transistor circuit, does not need a transistor radio to operate.
- Incorporates unique varicap tuning for extra stability.
- Search head fitted with Faraday screen to eliminate capacitive effects.
- Loudspeaker or earphone operation (both supplied).
- Britain's best selling metal locator kit. 4,000 already sold.
- Kit can be built in two hours using only soldering iron, screwdriver, pliers and side-cutters.
- Excellent sensitivity and stability.
- Kit absolutely complete including drilled, tinned, fibreglass p.c. board with components siting printed on.
- Complete after sales service.
- Weighs only 22oz.; handle knocks down to 17" for transport.

Send stamped, self-addressed envelope for literature.

Complete kit with pre-built search coil **£15.95**
Plus £1.20 P&P
Plus £1.37 VAT (8%)

Built, tested and Guaranteed **£20.95**
Plus £1.20 P&P
Plus £1.77 VAT (8%)

MINIKITS ELECTRONICS,
6d Cleveland Road, South Woodford,
LONDON E18 2AN
(Mail order only)

HI-PERFORMANCE ELECTRONIC (CAPACITOR DISCHARGE) IGNITION UNIT

...Good for your car and your pocket

Fit one to-day and SAVE, SAVE, SAVE!

Why pay more when you can enjoy the advantages of true capacitor discharge ignition (CDI) at virtually pre-inflation prices? The benefits to your car and your pocket are enormous — easy starting in the coldest of cold weather, an end to burnt contacts and arcing problems, better engine wear and petrol consumption and, of course, easy and secure fitting to your vehicle. ORDER NOW WHILE WE CAN HOLD TO THESE PRICES — State if pos. or neg. earth.

INC. V.A.T. AND POST FREE IN U.K.

READY BUILT ONLY **£14·95**

D·I·Y KIT COMPLETE **£12·75**

Why be without?

- MADE IN OUR OWN U.K. FACTORY
- SWITCH FOR INSTANT RETURN TO ORDINARY IGNITION
- NEG. OR POS. EARTH MODELS
- HEAVY GAUGE ENCLOSED METAL CASE
- BUILT FOR YEARS OF DEPENDABLE SERVICE
- FULL 12 MONTHS' GUARANTEE

Pay by Access or Barclaycard if you wish

STIRLING SOUND
37 VANGUARD WAY, SHOEBURYNESS, ESSEX
Tel (03708) 5543
Shop — 222/224 West Road, Westcliff-on-Sea.

To Stirling Sound, 37 Vanguard Way Shoeburyness, Essex
Please send .... Mark 5 Ready Built @ £14.95
.... Kit @ £12.75
NAME ....
ADDRESS ....
HE 10

AT BREADBOARD '78 Stand D3

THE SINCLAIR PDM35 digital Multimeter

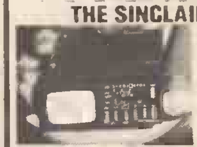
Now a digital multimeter at an analogue price and look at the spec!

D.C. VOLTS 1mv-1000v(1% — 1 count) 10mΩ input.
A.C. VOLTS 1v-500v. 40Hz-5kHz (1% + 2 counts).
D.C. CURRENT 1 inA-200mA (1% count).
RESISTANCE 1Ω-20mΩ (1.5% + 1 count).

£27.95 cash with order or £29.95 company purchase order.

A.C. Mains adaptor **£3.95**
deluxe padded carrying case **£3.20**
30kV probe £18.64

THE SINCLAIR MICROVISION



The amazing pocket T.V. that will pick up programs throughout the world, complete with rechargeable batteries.

£179.95 inc. VAT

Sae (for detailed Brochure ex-stock)

SINCLAIR DM235

Cash with order

Portable 3½ digit 6 function Multimeter.
DC volts 1mV to 1000V
AC volts 1mV to 750V
AC & DC current 1µA to 1A
Resistance 1Ω to 20mΩ
Diode test 0.1µA to 1 mA
10mΩ input, DC acc. 1.0% AC acc 1.5% 30Hz-10KHz

£52.80 inc VAT or £53 70 on company purchase order

A full range of optional accessories. (Prices include VAT)

DM 235 meter complete with test leads and prods **£52.80**
Eveready carrying case with lead storage compartment **£8.95**
Rechargeable battery units **£8.50**. AC adaptor/charger 240V 50 Hz **£3.75**. 30kV voltage probe **£18.04**

We accept govt /company purchase orders on all goods.

KRAMER & CO

We will match any lower advertised price om a cash with order basis if competitor has goods in stock

Dept. HEI. 9 October Place, Holders Hill Road, London NW4 1EJ
Telex 888941 Attn. Kramer K7. Tel. 01-203 2473
Mail order only. SAE for data sheets Export enquiries welcome

ETCH RESIST TRANSFER KIT SIZE 1:1

Complete kit 13 sheets 6in x 4½in **£2.50** with all symbols for direct application to P.C. board. Individual sheets 25p each. (1) Mixed Symbols (2) Lines 0.05 (3) Pads (4) Fish Plates and Connectors (5) 4 Lead and 3 Lead and Pads (6) DILS (7) BENDS 90 and 130 (8) 8—10—12 T.O.5. Cans (9) Edge Connectors 0.15 (10) Edge Connectors 0.1 (11) Lines 0.02 (12) Bends 0.02 (13) Quad in Line.

FRONT AND REAR PANEL TRANSFER SIGNS

All standard symbols and wording. Over 250 symbols, signs and words. Also available in reverse for perspex, etc. Choice of colours, red, blue, black, or white. Size of sheet 12in x 9in. Price **£1.**

GRAPHIC TRANSFERS WITH SPACER ACCESSORIES

Available also in reverse lettering, colours red, blue, black or white. Each sheet 12in. x 9in contains capitals, lower case and numerals ⅛in kit or ¼in kit. **£1** complete. State size.

All orders dispatched promptly.
All post and VAT paid
Ex U.K. add 50p for air mail
Shop and Trade enquiries welcome
Special Transfers made to order

E. R. NICHOLLS
P.C.B. TRANSFERS
Dept. HE/1
46 LOWFIELD ROAD
STOCKPORT, CHES. 061-480 2179

Introduction

THANKS FOR GETTING this, the first issue of **Hobby Electronics.** There must be some of you who have bought it out of curiosity only, others because they like what they've seen after a quick flick through on the news-stands.

Those who are curious may be wondering if there are enough potential readers for the very large number of magazines now catering to the hobby electronics field. Naturally, we think there is a readership for the contents that we are planning to include, a readership who find the projects and assumed knowledge in some other titles too advanced and / or expensive.

We make no secret of the fact that **Hobby Electronics** is a sister magazine of **Electronics Today International.** This issue is prepared and written by exactly the same team but we appreciate that we are to some extent aiming the content at a different readership.

Although we expect many of our readers to be newcomers to the world of electronics, we are not assuming that they are young, or unintelligent for that matter.

Hobby Electronics shares with **ETI** laboratory facilities where most of the projects are developed and produced; this gives us far greater control over them than the approach taken by some other titles of relying on outside contributors. However, the main difference between **ETI / Hobby Electronics** and other titles is that the editorial staff all share the same origins — they were all recruited from the ranks of the hobby itself and are still deeply involved.

In preparation for the launch of this first issue, we produced a 'dry-run', we called it a 'Preview' copy and conducted some readership research — mainly seeking reactions to the content. We would like to say thank you to those of you who responded. The results were gratifying in that no major change was asked for and we've stuck with our original plans.

Halvor Moorshead — Editor

Monitor

DIGEST

Litronix in the States have been commissioned to produce 'a pocket-sized electronic language translator'. It should be out around the end of this year.

The Financial Times International Management Report predicts that the world electronics market will increase by 70% to about £100 000m over the next five years.

Lee-Dickens Limited have built a battery-powered racing car capable of 100 mph.

Marconi Marine have produced an ultrasonic fish-finder with a colour TV output. It is claimed that this enables experienced fishermen to recognise the type of fish from its echo.

The Hong Kong Telephone Company is to buy the PO's information system, Viewdata.

Mount Sinai Hospital, New York, is expanding its pharmacy computing system with a drug-interaction program which will enable drug combinations to be selected more easily.

Scientists in West Germany have found a way of destroying gallstones without surgery by blasting them with high-intensity sound.

ALL CHANGE AT THIS STATION

Later this month the BBC will attempt the greatest feat in radiophonic confusion since the Orson Welles 'War of the Worlds' broadcast. It will achieve this by changing the frequencies of transmission of all four of its stations on the MW and LW bands.

The change will take place on November 23rd and there will be periods of blissful silence ranging from a few seconds to several minutes on the stations affected up to the fateful day.

Ironically, the changes (which are aimed at reducing interference from foreign stations) will affect the least organised of us least. Those who always have their trannies tuned to a particular station at a particular time will be confused most, while those who hunt the aether for some decent music will be almost unaffected.

The new frequencies will be:

Radio 1	275m and 285m
Radio 2	433m and 330m
Radio 3	247m
Radio 4	1500m

VHF remains unchanged (praise be).

From our press release file — the original caption read: "Fred the Flour Grader's discussion with Dennis Dugo, manager of the Grocery department at the SavaCentre hypermarket in Washington, Tyne and Wear, is interrupted by a "bleeper" call. Like most other departmental managers, Mr. Dugo always carries a Multitone pager . . . ."

CONFUSED WATCH

No, this is not a mechanical watch — nor is it a digital watch. This is Texas instruments' latest in timepieces. It is digitally controlled and manages to look like a mechanical watch by having a display which is split into 120 segments. These are made to darken as required to provide a watch which has all the advantages of a digital — accuracy, total lack of moving parts, robustness — with the major advantages of a mechanical — readability.

Naturally (well, we've come to expect this of technological miracles), it can also display the date or be used as a stopwatch.

Perhaps this is the forerunner of what many would consider a necessary change in electronic display philosophy. In the chemical industry, for instance, process operators (the guys who sit and watch dials all day) complain bitterly when confronted with a fully digital display. For this reason there have evolved a number of not-quite-digital alternatives — the most common being the 'line-of-light' type of display — dozens of very small light emitters in a line which light up to indicate temperature, humidity or whatever.

These psuedo-analogue displays have the advantage that they can be read quickly and easily to a low degree of accuracy — or more accurately if required by a longer look.

How many times have those of you who own digital alarm clocks woken up and had to spend a good ten seconds just trying to work out what time it was?

Well done, Texas — keep up the good lateral thought.

COMPUTER READ IN

Optical character recognition (OCR) is the term for computer recognition of printed matter. This hand-held OCR scanner by Siemens, when passed along the line of text, enables the attached minicomputer to 'read'.

As each letter passes under the device, its shape is recognised by the computer, enabling it to take in text at a rate of up to 140 characters per second. The applications seen for the device (which can read most computer inputs) include reading tags or labels at point-of-sale and checking ID cards.

The scanner, which weighs only 5 oz, can be passed over the text either from left to right or from right to left. The machine will tell the operator if it has failed to recognise any of the characters.

News from the Electronics World

UNDERWATER SMARTIE

The name of the vehicle is Submarine Automatic Remote Television Inspection Equipment — SMARTIE for short. Basically, it consists of an electrically-powered underwater platform, bristling with television cameras — including at least one Silicon Intensified Target (SIT) camera for low light levels.

The real beauty of the device, though, is the on-board microcomputer. This aids the operator in his task of manoeuvring the vehicle to where it is required. For instance, it can add to the TV picture an artificial navigation 'target' which the operator can follow on his TV screen, even though the craft may be passing through an area of zero visibility. Another feature is the 'hold' button: the computer will automatically compensate for the effects of sea currents, keeping the vehicle in the required position without intervention.

The vehicle is supplied with power and control signals by a cable a mere ½ cm in diameter. The TV pictures are transmitted back to the surface via the same cable. The use of such a thin cable (other similar craft use much thicker cables, each signal using a separate wire) reduces the drag effects which can affect the performance of the vehicle.

PSST .... LOOKING FOR A FENCE?

A new electronic steel fence watchdog from ARC (Europa) Ltd. is based around "micro-miniature mercury switches" (tremblers to those of our readers who happen to be WW2 bomb disposal experts) and will raise an alarm if anyone attempts to cut or climb the fence.

Called the 'Perim-Alert', the unit can be fitted with minimal electronic knowledge and comes complete with a control unit which allows spurious signals from high winds, cats, et cetera to be ignored automatically. Several units can be installed on the same fence — the control unit will tell you which section of the fence is being 'tampered with'. A separate circuit detects attempts to tamper with the units themselves.

Obviously, the next step is to build electronic alsatians to respond to the alarm signals.

3-D COPIER?

A company in the States (Battelle Labs.) are at present negotiating with a group of manufacturing licensees for the production of a "3-dimensional replicator". The system will operate by firing two laser beams at a tank of liquid chemical reagents. The lasers are designed so that one beam on its own will not affect the chemicals because of insufficient energy. However, when the two beams meet, the total energy will be enough for the chemicals to react to form a solid.

The computer-controlled beams would be scanned across the bath of chemicals, building up a solid object of the desired shape. The excess fluid could then be drained off. By using the appropriate chemicals, it is hoped that it will be possible to produce metal objects.

The introduction of the colour photocopier has had little effect on society (except perhaps as a boon to forgers!) but it seems that the 3-D system will have a greater impact — furniture made to measure while you wait? Stone gnomes wearing your own face gracing your garden? The possibilities are limited only by imagination . . .

SIX STOREY SPEAKER

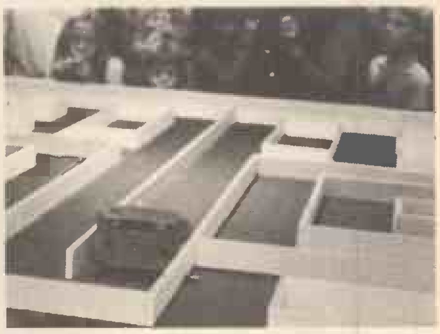
To someone not familiar with the principle of Bose 901 direct/reflecting speakers, the temptation to place their triangular backside neatly into a corner must be strong indeed, but the result of so doing can have somewhat amazing consequences.

When Bose's UK PR man, taking his family on holiday to Italy, arrived late at the Conca Park Hotel in Sorrento, a much-needed early night was marred by the thumping beat of the hotel disco. Re-dressed and angry — the noise was appalling — he went in search of the offending DJ. Up first to the sixth floor where the noise was loudest — but no disco. Next, down to the basement — success, but inside the disco comparative quiet, in fact a rather muffled sound.

There, in two corners, a pair of 901s, hard against the wall, pumping 80% of the sound into the wall cavity and in so doing, turning the entire hotel into a giant speaker system.

A word of friendly advice was well received and immediately responded to. Then with the speakers moved — 18 inches from the wall and twice the distance from each corner — the disco resumed. The difference actually brought a round of applause, and a good night's sleep was had by all.

SQUEAK, SQUEAK



Well, it's certainly not a man, so it must be a mouse!

This is a photo of one of the 'contestants' of the 'Spectrum Computing Magazine Amazing Micro Mouse Maze Contest Trial Run' (whew!). The idea is that the (human) contestants build a microprocessor controlled animal for the express purpose of finding it's way out of a wooden maze. The entries are not allowed to "jump, fly or burrow" and the winner is the one which finds it's way out fastest.

The competition was run at this year's 'Personal Computing 78' show in Philadelphia. The fastest time achieved in the contest so far was about 50 seconds, at the trial run in California.

Although there are no plans so far to run the competition in the UK, we're sure that if enough interest is shown . . . Any mice out there?

HE

Electronics From Scratch

To anyone just starting out in electronics, the apparent complexity of the subject is daunting but in reality it's simpler than it looks. Phil Cohen explains some of the foundations of the subject and gives a few tips on how to get started.

Do you need to be a genius to get into electronics?
The answer is no. Electronics is a great deal simpler than most people imagine. This is at least partly due to the fact that manufacturers of radios and TV sets have built up the image of the white-coated technician slaving over a hot workbench, shouting "Eureka!" every so often. This adds to the image of the product. Designing an electronic circuit is about as difficult as planning a meal or keeping a garden. Of course, designing a TV set from scratch is equivalent to planning a banquet or running a national park, but you have to walk before you can run!

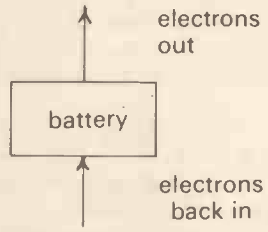
What do you need to follow electronics?
You need a small income (I started on pocket-money), although a large income will do if you happen to have (a kitchen table will do), and a small collection of tools — a soldering iron, wire cutters and screwdrivers.

Where do I start?
All of electronics is concerned with the flow of electricity, its control and application, so the best place to start is by finding out about electricity.

Well, what is electricity?
It's a fluid which can flow only through metals. When it meets air or plastic, it stops. It's strange to think of something flowing through a solid — the reason why it can occur is that electricity is made up of tiny particles (electrons) and all solids also contain electrons. As the electricity flows into one end of the metal, the electrons in it are all pushed along and some fall out of the other end. The reason why this *only* happens with metals (and with a few other materials) is that in most solids, such as wood or plastic, the electons in the material are fixed and are not free to move. In metals, however, they are free and can 'flow' down a metal bar as long as they are replaced at the top and have a place to go at the bottom.

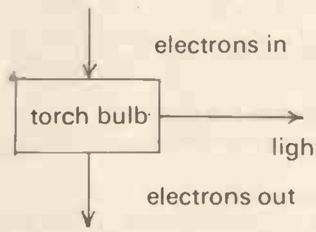
How do you use electricity?
Well, first we need a pump — something which will push electricity out of one end so that we can use it. A battery is such a device. The chemicals in the battery push electricity out of one end of it. Where do these electrons come from? Remember I said that all materials contain electrons? Well, it's the electrons from the chemicals in the battery which are being pushed out. If this went on indefinitely, it would mean that there would be no electrons left. This cannot happen, because the chemicals will stop working long before that. They will only pump a very small number of their electrons out without replacement.

How does a battery work, then?
I said that the electrons in the battery couldn't be pumped out without replacement. What we do is to put another terminal on the battery and pump electrons back in. This is why a battery has two terminals — the electrons come out of one and go back in through the other.

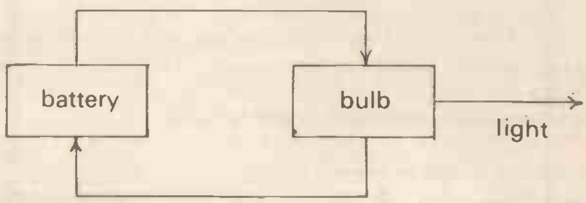


What use is a battery if we don't get any net outflow of electrons?
The battery isn't meant to be a source of electrons, remember, it just pumps them round. A water pump has to have an inlet and an outlet, too.

What do we do with this pump?
We can use it to push electricity throught something (a torch bulb, for instance). In a torch bulb, it's the fast flow of electricity that does the work — electrons are not used up:



So when we connect a battery to a bulb . . .?
Electrons flow in a circle, yes:



What is 'Ohm's Law'?
I said that a battery was like a pump — right? Well, each type of battery can push with a certain pressure — different batteries have different pressures. Electric pressure (called 'voltage') is measured in units called 'volts'. A small transistor radio battery is about nine volts (9V). Now, the *amount* of electricity flowing in a circuit is

called the 'current' (like the current of a river) and is measured in 'amps'. A 13 amp (13A) mains plug will carry a current of up to — you guessed it — 13 amps. A 3 amp fuse will 'blow' if you try to force more than 3A through it.

Ohm's Law states that the harder you push, the more happens. To put it another way, if you double the voltage across something, the current through it will double (this is only true for some 'somethings', by the way, but more of that later).

For a given 'something', we can write:

current = voltage ÷ (a constant)
or voltage = (a constant) x current
or V = R x I,
where V is the voltage,

I is the current (we always use I for current for some reason I can't fathom) and R is a constant.

Now, R will be different depending on what the 'something' is that we're forcing current through, and each 'something' has a certain value of R. We call R the 'resistance'. An object with a high resistance (a high value of R) will resist the flow of electricity, causing a small current for a given voltage. An object with a small resistance will allow a larger current to flow for the same voltage.

If you've read and understood this so far, then you've mastered a large part of elementary electronics! In fact, you understand the difficult bit — the theory. What you need now is to gain some experience. To give you some idea of how to go about gaining expertise in electronics, we've interviewed some of our staff — all of whom started out as amateurs — to find out how they started from scratch.

Jim Perry, 27, technical journalist:

When did you start becoming interested in electronics?
When I was about nine. It wasn't really electronics at that stage, it was bulbs and bits of wire and things like that.

What was the first thing you built?
Apart from just messing about, I didn't really build anything *electronic* as such until I was about twelve. Then I built a thing which produced a sound like a police siren.

Where did you get the design?
From 'Radio Constructor' magazine. (One of our competitors! — Ed)

How much did it cost?
About three quid — I had to save up for a few weeks to get the cash together, but I got a great kick when it worked.

What made you take electronics further?
As I said, I got a tremendous buzz out of building this thing and that made me more interested in electronics. I started buying 'Practical Electronics' (*Another* competitor! — ED).

Did you understand everything in it?
No, of course not, but as I read more issues of it I sort of filled in the gaps as I went along.

Apart from your job, do you still follow electronics?
Yes, I still sit down with my soldering iron and build things — only now they do a bit more than sound like a police car.

Mark Strathern, 34, Advertising manager:

When did you first become interested in electronics?
About eighteen months ago.

Why electronics?
I started to realise — from what the Press was saying — that microprocessor and minicomputer advances were going to have a massive impact on society. I decided to find out more about these advances and their potential.

What was the first thing that you built?
I built an audio amplifier, the design for which I had read in 'Wireless World'. It didn't work at first — in fact I probably gained more from finding the fault in my construction of the device than I did from building it.

How much electronics does your job entail?
Obviously, it helps greatly if an advertiser can speak to someone who knows a little about the product he's trying to sell. I *could* do my job without a knowledge of electronics, but I follow the subject because I think it important — and because I enjoy it.

JUNK

Most people who've been into electronics for a while find that they've built up a 'junk box' — a load of miscellaneous components which for one reason or another have been not been used. This collection of what is ostensibly a load of old rubbish is in reality extremely useful — not only can the bits be used to replace things that go bang in the night (i.e. faulty components), but entire projects can sometimes be cobbled together out of it. For this reason, I have given below a list of bits which you are likely to find the most useful. My suggestion is that you buy whatever of these you can get your hands on as a sort of 'instant-start junk box'. The resistor and capacitor values were chosen (by computer, no less!) as being the most commonly used and the rest of the bits are what we at HE consider to be the most useful. HE

TRANSISTORS

type	number
BC109	8
AC128	3

DIODES

type	number
1N914	6

Light emitting diodes: 2 (these come in a variety of colours — choose the ones you fancy).

INTEGRATED CIRCUITS

type	number
741	2
555	2
4011B	2

RESISTORS (all ¼ watt)

type	number
100k	15
10k	15
1k	10
10M	5
2k2	5
330R	5
4k7	5
47k	5
4M7	5

CAPACITORS

type	number
100n	10
10u	10
10n	5
100u	5

MISCELLANEOUS

One PP3 battery clip; one PP3 battery; one 2" or 3" loudspeaker; one on/off switch (mains); about 8 square inches of veroboard (try to get off-cuts — they're cheaper); about 10m of the cheapest single core insulated wire you can get (at about 2p per metre); about £1 worth of cored solder; 1m of cheap microphone cable at around 10p per metre; a general purpose soldering iron (not a solder gun!); wire cutters and screwdrivers (you may well have these in your tool box already).

Into Electronics

by Ian Sinclair — Part 1

This is the first part of a series which will cover electronics along the O/A level syllabus. It is designed for the beginner who has taken O level physics or physical science. Although those who do not have a relevent O level will be able to follow the course easily, they may have to do a little reading around the subject.

ANYTHING CALLED ELECTRONIC is also electrical, so that we need to start by understanding and being able to use some common electrical terms. Let's start with current. Any current is a flow of something, perhaps of substances that can be seen, like water; sometimes of invisible materials like air. Electric current is a flow of invisible particles. Luckily, they make themselves felt in other ways. The name we give these particles is electrons.

Electrons are tiny particles, parts of the atoms that all materials are made of. When we rip electrons away from their atoms, we find that they are strongly attracted back again. This is what happens when a plastic ruler is rubbed with a piece of cloth — some electrons are rubbed off the ruler and on to the cloth (or sometimes the other way round). The ruler will then pick up small pieces of paper because it is trying to get its electrons back (if it lost them), or trying to give them back if it gained them. This force between the electrons and the atoms which lost them is a strong force. It has to be when a ruler can pick up a few bits of paper which the entire Earth is attracting downwards with its gravity. Unlike gravity, though, the forces between particles like electrons can act to repel particles apart as well as to attract them together.

ELECTRIC CHARGE

The force of gravity that keeps the planets in their orbits is caused by the quantity we call mass, so shouldn't there be some quantity that causes these forces, called electrostatic forces, between electrons and the atoms? We call this invisible quantity 'charge', or 'electric charge', and careful measurements show that each electron carries the same amount of charge.

Two types of charge exist; we call them negative (—) and positive (+). These two types of charge cause the two directions of force, because a positive charge always attracts a negative charge, but two charges of the same sign (two positives or two negatives) repel each other. Which type appears on an electron? It doesn't matter, but we decided this a couple of hundred years ago — we call the sign of charge on the electron negative.

When an electron moves, or any other charged particle moves, it takes its charge with it, and this movement of electron charge is what we call electric current. When charge moves like this, the average amount of charge passing a point per second is the quantity of current. We could, if we liked, take the unit of current as the amount flowing when electrons move past at the rate of one per second. Even with the sensitive instruments we use now, though, this would be too small a unit, so that we use the unit called the ampere, shortened to amp. We can measure one amp without counting electrons — which is just as well, because a current of one amp means six and a quarter million million million electrons per second.

Because of the strong electrostatic forces, we can't take all these millions of electrons away from a material. If we are to move all these millions of electrons every second, we need to replace each electron that is separated from an atom. This can be done by using a circuit. To understand this, think of another type of example. Suppose we pump water from one tank to another, higher up. The pumping and the current of water has to stop when the lower tank is dry. We can keep the current flowing only if the lower tank fills again, and the easiest way is to allow water to flow back from the higher tank. What we have now is a water circuit in which the water can keep circulating — we use such a circuit for central heating systems. In an electrical circuit, electrons circulate through wires. The pumping

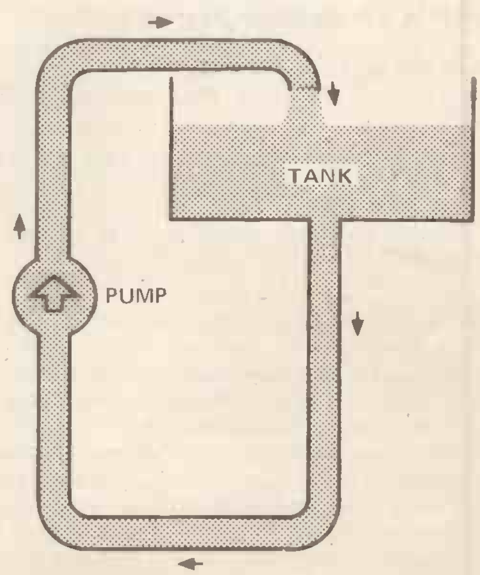


Fig. 1. Currents. A water current, moved by a pump, can be kept moving if the same water is constantly re-cycled.

is carried out by a battery or generator, and electrons are pumped to a part of the circuit, a torch bulb perhaps, and allowed to flow back along another wire. In every electrical circuit, the amount of current leaving the battery or generator must be equal to the amount of current returning to the battery or generator. When electrons move in a circuit, causing an electric current, three effects can tell us that the electrons are moving. One effect is heat — when an electric current flows through a material heat is given out so that the temperature of the material rises. Another effect is magnetism. When electrons move they cause magnetism which can be detected by a compass needle. The third effect is the chemical separation which we make use of in electroplating.

PUSHING IT ABOUT

No current flows unless something moves it along. Water flows because the force of gravity pulls water from high places on Earth to lower places: air flows because the pressure of air at one place is higher than at another. The quantity that drives electric current is called electro-motive force (shortened to EMF) and is measured in units called volts (V). EMF exists wherever energy of some sort: heat, chemical energy, light or motion is converted into electrical energy, even if there is no flow of current. A battery will have an EMF, 9 V for example, whether it is connected to a circuit or not, because the chemical action inside the battery has created the 'push' which *could* move a current round a circuit. When we use an EMF to cause a current, energy is converted and the chemical action of the battery continues. The value of EMF can be measured by a 'voltmeter'.

When an electric current flows, we find that we can take 'voltage' readings with the voltmeter at parts of the circuit other than the battery. These readings are of 'potential difference', also measured in volts. The distinction is that these readings of potential difference (PD) are caused by the current and will disappear when the current stops flowing. The sequence is that EMF causes current which causes PD. If we divide any circuit into sections (Fig. 3) then the PD across each section can be measured. Adding all of these PD values gives just the amount of the EMF.

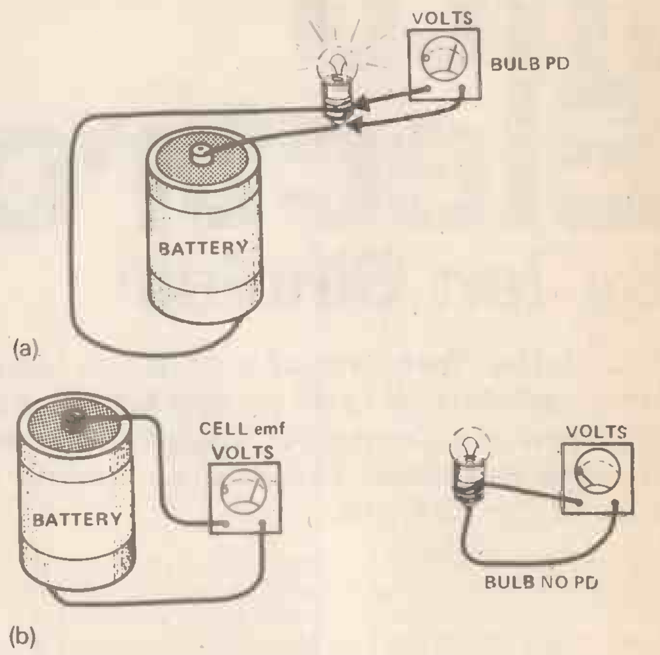


Fig. 2. EMF and PD (a) When a cell and a bulb are connected, we measure a PD across the bulb (b) When the cell and bulb are disconnected, we measure an EMF across the cell, but no PD across the bulb.

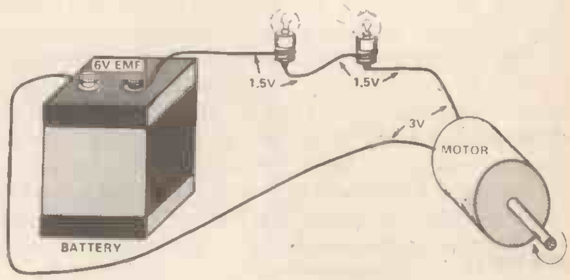


Fig. 3. In a complete circuit, the PDs across each section of the circuit, with the same current flowing, add up to the EMF.

POWER AND MORE POWER

When an EMF causes a current to flow, power is being converted into its electrical form. The amount of power is measured in units of watts (W), and the number of watts being converted in any part of the circuit is found by multiplying the number of volts of EMF or PD by the number of amps of current. Power is the rate at which energy is converted from one form to another (energy is never created nor destroyed), so that the amount of power equals amount of energy changed

time taken.

When we multiply the amount of EMF by the amount of current flowing in a complete circuit, the figure of power obtained is the amount of power converted into the electrical form. This power is converted back to other forms in the circuit: Perhaps somewhere in the circuit a wire is heated by the current, so that power is converted into the form of heat. The amount of power converted into this form can be found from electrical measurements. We measure the PD across the wire, and multiply this value by the amount of current flowing through the wire. For example, a 6 V, 0.3 A torch bulb will convert 6 × 0.3 W, or 1.8 W of electrical power into heat and light. Whenever we multiply an EMF value by a current value, the result is power converted into the electrical form inside a battery or generator. When a PD value is multiplied by a current value, the result is the amount of power converted out of the electrical form into some other form such as heat, light, magnetism etc. in a circuit. When the conversion is into heat, we usually speak of the power being dissipated, because we cannot recover the energy again.

OHM, SWEET OHM

These quantities, EMF of PD, current and power are all related to each other, so that when we pick a value of EMF to use with a circuit we also settle how much current can flow and how much power is converted. In any circuit or part of a circuit, the ratio of the voltage reading across the circuit to the amount of current flowing through it, V/I, is called resistance, symbol R, units ohms. For example, a voltage of 6V and a current of 2A means that the resistance is 6 / 2 = 3 ohms. At one time, the Greek capital omega was widely used to mean ohms, nowadays the letter R is used, so that a resistance value of 10 R means ten ohms.

For circuits made using metals, carbon, and many other conducting materials, the resistance of a conductor is constant while the temperature is constant, it does not change when the current or the PD are changed. This was discovered by George Ohm, and is called Ohm's law. If we know that a resistance value is constant, then we can calculate the amount of voltage across the resistance, knowing the amount of current; or we can calculate the amount of current, knowing the voltage. If Ohm's law is not followed, then the calculation is not so easy as we shall see when we start to use semiconductors.

MULTIPLES AND SUB-MULTIPLES

The measuring units of volts, ohms, amps and watts are just the right size for many *electrical* measurements. For electronics use, however, we often need larger units (particularly in ohms) or smaller units (especially for amps). This avoids having to use quantities such as 0.00016A or 1 200 000 ohms repeatedly. To cope with this we use a standard set of prefixes (see Table 1) to convert the units into multiples or submultiples, all powers of ten. For example, the prefix micro — means 10^{-6} (one millionth), so that 0.000 16A is 160u A, 160 microamps. Mega means one million (10^6) so that 1 200 000 ohms can be written as 1.2 M (the 'R' of ohms is often left out). By choosing our multiples or sub-multiples, we can avoid having to use very large or very small numbers, and we can also make calculations easier.

Using Ohm's law in the form V = R.I, for example, we would normally have R in units of ohms and 1 in units of amps, giving V in units of volts. If we use units of k for resistance and mA for current, the result is still involts, because k x m is 1000 x 1/1000, which is 1. Similarly, a value of resistance in M multiplied by a current in uA will also give a value of V in volts. For example, 2uA flowing through 3.3M will cause a voltage of 6.6V, and 3mA flowing through 10 k will cause 30V.

For each electronic circuit, there will be a correct value of 'supply voltage' which will cause the correct current for the circuit. For example, a battery-operated circuit rated at 9V might take a current of 60mA, so that the power drawn from the battery is 9 X 0.06 = 0.54W. We could not operate this circuit correctly from a 100V supply, because the higher voltage would cause the circuit to take a higher current and dissipate much more power, probably enough to destroy the components. Similarly, if we have a circuit that needs 150V at 0.3A (45W), we cannot expect it to operate from a 9V battery, because a 9V battery does not supply 150V, cannot push 0.3A through the circuit, and cannot provide 45 W to this circuit.

AC AND DC

The EMF from a cell or battery has a steady value, almost constant for the whole of its life. This is a steady EMF; connect it to a circuit and you have a steady current if the circuit has a constant value of resistance. The cell gives DC (direct current), direct meaning that the current is steady and in one direction. This type of supply is essential for most types of electronic circuits, so that we need batteries or mains-operated direct current power supply units (PSU) to operate our electronic circuits.

That's about all we use DC for, though. In almost every use of electronics we have voltages which are not steady but which change voltage in a definite pattern, so many times per second. Plotting a graph of voltage against time gives a recognisable shape, the waveform, so that we talk of sinewaves, squarewaves, or sawtooth waves, depending on the way in which voltage varies. Voltages like this are called alternating voltages, because their voltage value alternates from high to low, or positive to negative, and back again in a complete cycle.

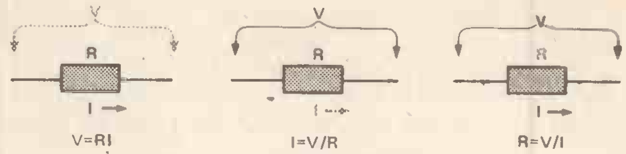


Fig. 4. Ohm's law in its three forms.

Prefix	Name	Value	Power of Ten
M	mega-	1 000 000	10^6
k	kilo-	1 000	10^3
m	milli-	1/1 000	10^{-3}
u or µ	micro-	1/1 000 000	10^{-6}
n	nano-	1/1 000 000 000	10^{-9}
p	pico-	1/1 000 000 000 000	10^{-12}

Note. do not confuse M (mega) with m (milli).

TABLE 1. Prefixes for multiples and sub-multiples.

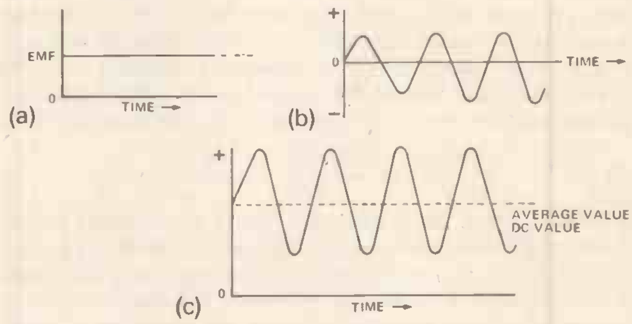


Fig. 5. AC and DC (a) The EMF from a cell is steady — a graph of EMF plotted against time is a horizontal straight line. (b) An alternating EMF has alternate + and — values which repeat at definite intervals. (c) When AC and DC exist together we may find that there are no negative (or no positive) values of EMF.

An alternating voltage can exist alone, or along with DC or other alternating voltage. When we have an alternating voltage by itself, the value of voltage always alternates between + and — values, and the average value is zero. Because of this, a DC voltmeter connected to an alternating supply reads zero volts. When an alternating voltage and a steady voltage are present together, the average value of voltage is just the value of the steady voltage. We can, if we like, arrange the value of the steady voltage so that no negative voltages (or, if we like, no positive voltages) exist. This action goes by the splendid name of 'applying a steady bias'.

The 'smoothest' form of variation of voltage is the sinewave; which is the waveform that is generated when a coil of wire is rotated between the poles of a magnet. This is the waveform of the mains supply (line voltage) used in every country in the world, and generated by alternators. A supply like this has an average voltage of zero, but in a circuit it will cause an alternating current to flow, and the alternating current will also have the same waveform, the sine wave. Because of this, the average value of current is also zero. Electrons are moving in all parts of the circuit, though, so that power will be converted to heat in each resistance in the circuit. Whatever our meter reads, power certainly isn't zero!

The disagreement is caused by the way the meter works. A DC meter is sensitive to the direction of current through it. A current in one direction deflects the needle clockwise, a current in the opposite direction deflects the needle anticlockwise. An AC (alternating current) wave, changing direction many times per second causes no deflection of the needle, because the DC meter simply cannot respond fast enough, and the needle remains at the average value of zero. A resistor will dissipate power no matter what the direction of current may be through it.

Since a DC meter gives no readings of AC, we need some method of measuring the AC waves we use so much. The best method is to measure the peak-too-peak voltage of the wave using an instrument called the cathode-ray oscilloscope (CRO) which can present a graph of the waveform on a screen of a cathode-ray tube. Peak-to-peak voltages of any waveform can be measured in this way.

Waveforms like sinewaves have a negative peak voltage equal to their positive peak voltage, so that we often measure only the peak voltage (half of the peak-to-peak voltage). In addition, power engineers have for many years used a measurement called RMS (root mean square) for sinewaves. This is based on the fact that if we multiply peak values of AC voltage and current together, we obtain a figure for power which is exactly twice as much as the true measured power. If, instead of using peak values we take 0.707 times each peak value, the power calculation comes out correctly, because 0.707 is $\frac{1}{\sqrt{2}}$ and $\frac{\text{voltage}}{\sqrt{2}} \times \frac{\text{current}}{\sqrt{2}} = \frac{\text{power}}{2}$ which is what we want. The name root mean square comes from the theory which also arrives at this figure of 0.707 for a sine wave only. For electronics purposes, RMS values are seldom of interest, the main exception being when the power output of an amplifier is being measured. RMS values using the factor of 0.707 can be used only when the waveform is a sine wave.

TRANSDUCERS—THE QUICK-CHANGE EXPERTS

Microphones, loudspeakers, TV camera tubes, electric light bulbs; all are transducers. A transducer converts power from one form to another, sound, heat, light, electricity, mechanical movement, whatever is needed. A microphone converts the power of the sound waves reaching it into the power of an electrical waveform. A loudspeaker performs the opposite conversion, from electrical signal into sound output; both are transducers. For electronics purposes, the most interesting transducers are those which have electrical inputs or outputs. Using transducers with electrical outputs, for example, we can convert quantities such as temperature, sound intensity, light intensity, distance, speed or force into electrical quantities which may be steady or alternating voltages or currents. We can then use these electrical quantities, which we now call signals, in our electronic circuits to detect, measure or control the quantities that have been converted. This is what electronics is about, and it is the use of transducers that makes it possible, so that we can have electronic thermometers, sound intensity meters, light meters as well as the familiar record players and tape recorders.

Transducers which work the other way round will convert electronic signals into other forms of power: heat, light, sound, motion and so on. Using both types of transducers means that we can make an electronic circuit part of any system, whether mechanical, acoustical (sound), optical (light) or thermal (heat). If there's a transducer for it, we can control it.

Most transducers have rather low efficiencies, meaning that the amount of power output of the form we want is pretty low compared with the amount of power at the input. The ratio

$$\frac{\text{power output in wanted form}}{\text{total power input}}$$

is the quantity (usually written as a percentage) which is taken as the efficiency figure of the transducer. For many

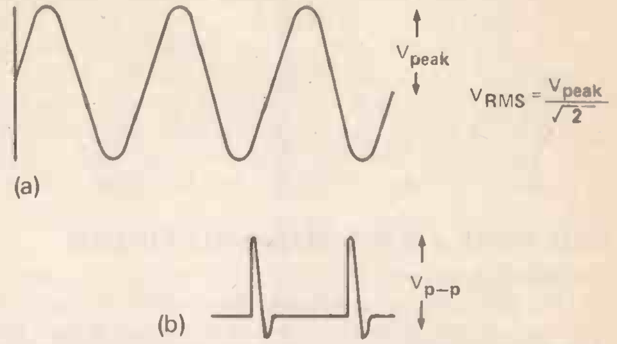


Fig. 6. (a) Peak and RMS. For a sinewave only, RMS voltage = peak voltage / $\sqrt{2}$. Using RMS values in power calculations will give true power (wrongly called RMS power) (b) Peak-to-peak measurement, often used in electronics.

Transducer	Action	Notes
Thermocouple	Temperature *difference* generates a steady EMF of a few millivolts	Two thermocouples are needed EMF is proportional to temperature *difference*
Thermistor	Change of temperature causes change of resistance	Can be PTC — resistance increases as temperature increases, or NTC, with opposite action.
Microphone	Sound wave in gives AC wave out	Low efficiency, very small output voltage
Loudspeaker	AC wave to sound wave	Low efficiency, sometimes less than 1%
Photocells	Light intensity converted into EMF, or causing change of resistance	Photovoltaic cells give steady EMF output, photo-resistive type change resistance
Accelerometer	Acceleration causes steady EMF	Acceleration causes force on a crystal which generates EMF. Very high resistance. Output can be processed to obtain speed and distance readings
Strain gauges	Strain (stretch) causes change of resistance	Metal or semiconductor wires change resistance as they are stretched
Light Emitting Diode (LED)	PD to light	Operate at low PD and current
Tacho-generator	Rotational speed to EMF, AC or DC	Used in control of mechanical systems
Servo-motor	AC or DC to rotation	Used in control of mechanical systems

TABLE 2. Transducers.

transducers this will be less than 5%, so that less than 5 parts per hundred or 1 in 20 of the power in gives a useful output — the rest goes to heat. Motors and generators usually manage higher figures for efficiency, up to 70% for small units, more for larger ones. Transducers for light and sound (photocells and microphones) always have very low efficiency figures. For most applications, the efficiency figure is not too important because we can amplify the power of the electronic signal to compensate for the loss in the transducers.

RESISTORS

Resistors are the circuit components that are used to control the amount of current that flows in a circuit, making use of Ohm's law. For example, if we want to have a current of 1.5 mA flowing in a circuit, using a 9 V supply, then (remembering that we can use units of mA, V, and k in the formula) we need a resistance value of 9/1.5mA, which is 6k, in the circuit.

Resistors are also used in 'potential divider' circuits. As the name suggests, the potential divider gives an output voltage which is a definite fraction of the input voltage: half, quarter or whatever we like. Suppose we have a 9V battery and we find we need a voltage of 1.5V at some part of a circuit. One solution would be to use a separate 1.5V battery, but the more usual method is the use of the potential divider arrangement as shown in Fig. 8. The circuit consists of two resistors connected in series as shown, so that the total resistance is the sum of the resistance values, R1+R2. If the supply voltage is V, then the amount of current flowing, by Ohm's law, is V/R1+R2. When a current passes through a resistor (Ohm again), there is a voltage across the resistor equal to resistance×current. Using this principle, the voltage across R2 must be R2×V/R1+R2 or V.R2/R1+R2. For example, if R1 is 10 k and R2 is 1 k, then for V=9 V, the voltage across R2 will be 9×1/10+1=9/11V or 0.82V. If we make R1=R2, whatever the values of R1 and R2, the output will be half of the input voltage. For our earlier example in which we wanted 1.5V from a 9V supply, we could use the values of 6.8k and 33k for R2 and R1 respectively. This does not give exactly 1.5 V but is as close as we can get using 'preferred values' (see later) of resistors. A point to remember about these potential dividers is that the calculated voltage holds good only if no current is drawn from the circuit. If current is to be taken from the divider, then the current flowing through R1 and R2 should be at least ten times the amount of current taken from across R2.

The potential divider acts in the same way to divide alternating voltages. One useful application is the 'potentiometer' or volume control. A potentiometer is a resistor fitted with a third sliding contact which can be moved from one end of the resistor to the other. The third contact converts the resistor into a potential divider and because the contact can be moved, the voltage at the contact can be varied. A potentiometer can be used to adjust a DC or AC voltage. When the adjustment has to be made frequently, the potentiometer will be fitted with a control knob and will be placed where it can be adjusted. 'Preset' potentiometers are used for adjustments which have to be made only during overhaul, and are fitted with screwdriver slots for adjustment.

A third use for resistors is in coverting current signals into voltage signals. 'Active' components, such as transistors, give, at their output terminals, alternating currents which we often need to change to alternating voltages. A resistor, called the load resistor does this because of Ohm's law. For example, if a transistor gives

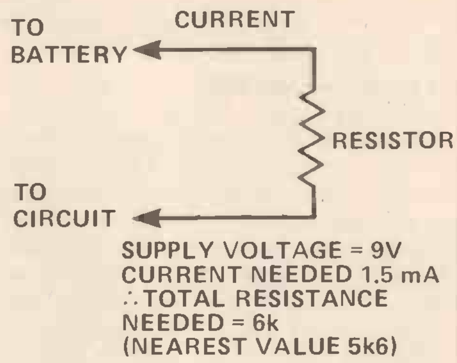


Fig. 7. Using a resistor to control an amount of current.

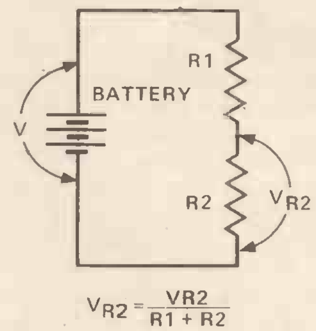


Fig. 8. The potential divider.

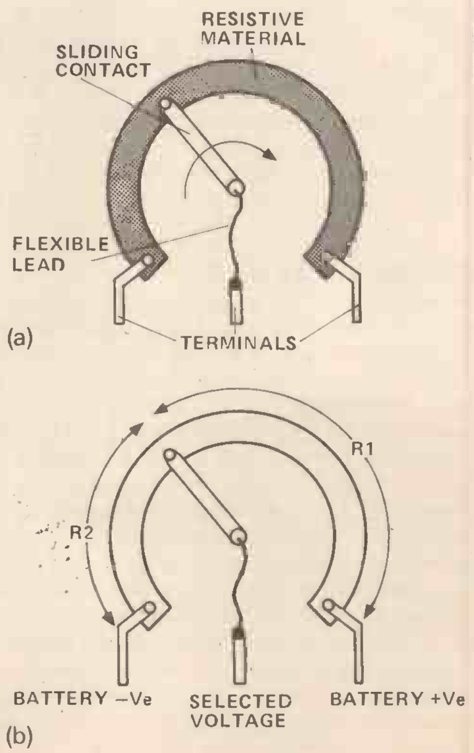


Fig. 9. A volume control is a variable potential divider. (a) construction, (b), use in setting a steady voltage level.

a current signal of 0.5 mA peak-to-peak, then passing the current signal through a 10 k load resistor will convert the current signal into a 5 V peak-to-peak voltage signal (because 0.5 mA×10 k=5 V).

PRACTICAL POINTS

Resistors can be made from any conducting material, provided it can be worked into the required shapes, but carbon is the most favoured material. The electrical resistance depends on the length and the diameter of the resistor, as well as on the material itself. For high resistance values we need long pieces of material with a small diameter and preferably a material with a high comparative resistance (high resistivity). Carbon composition resistors use a mixture of carbon and clay (like pencils) pressed into rods to achieve resistance values ranging from about 1 Ohm to several million, but the accuracy of value is not very good, usually about 20%. We can pick out values whose percentage accuracy or tolerance is closer, but this selection process makes the resistors much more expensive, so that we try as far as possible to work with 20% tolerances. More recently, resistors have been made by evaporating carbon or metal films on to ceramic rods and then cutting spiral patterns on the material to achieve resistance values with better tolerances. Such carbon or metal film resistors are now quite common, and are reasonably priced. For a few applications, resistors are made from wire wound on ceramic rods. Each type of resistor is protected by a hard plastics or ceramic casing which also has the colour-coded value printed on it.

There is no connection between the physical size of a resistor and its resistance value, but the physical size greatly affects how much power can be dissipated as heat. When a current, DC or AC (using RMS quantities) is passed through a resistor, the amount of electrical power converted to heat is given by $R.I^2$ (resistance value×square of current value). For example, a 10 k resistor with 5 mA flowing through it converts $10\,000\times(0.005)^2$ watts of electrical power, which is 0.25 W, into heat which must be passed on (dissipated) into the air about it. If the heat is not passed on, the temperature of the resistor will rise until it melts, breaking the circuit. Small resistors will dissipate 0.25W or less, and the larger power ratings need larger sized bodies. For power dissipations of 3 W or more, large wire-wound (abbreviated to WW) resistors must be used.

PREFERRED VALUES

Just as we buy paint in tins of definite size we buy resistors in preferred values. These values are chosen so that all the resistors turned out by the manufacturing process can be used; there are no rejects. For example, if we aim to manufacture a 10 k resistor of 20% tolerance (between 8 k and 12 k), then a 7 k or a 13 k resistor is not reject, because the 7 k can be sold as a 6.8 k and the 13 k as a 15 k. In each case these values are well within the tolerance of 20% of the stated value, and the values in the preferred series have been chosen so that 20% up on one value overlaps with 20% down on another. The preferred values in the 20% range are also used for the 10% range and others, with intermediate values, as needed. Note that we can have a 6.8k resistor in any of the ranges, but a 5.6k resistor is not found in the 20% range. We use the same set of numbers, each of two figures, whether these are single ohms, tens hundreds, thousands or higher multiples. Generally nowadays, you will find the decimal point replaced by a letter; R meaning ohms, k meaning thousands or M meaning millions. This system (British Standard 1852) is used so that the disappearance of a decimal point in copying or printing operations does not cause any confusion. The same system can be used for capacitance values such as 4u7, and voltage readings, such as 5V6.

20%	10%	20%	10%
1.0	1.0	3.3	3.3
	1.2		3.9
1.5	1.5	4.7	4.7
	1.8		5.6
2.2	2.2	6.8	6.8
	2.7		8.2

Examples of values, 20% series: 47k, 220, 3.3k, 150k
Examples of values, 10% series. 47k, 120, 3.9k, 180k
The first line would now be written as. 47k, 220R, 3k3, 150k using R to represent ohms, and placing k or R (or M) in place of the decimal point.

TABLE 3. Preferred values, used for resistors, capacitors and zener diodes.

Colour	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Purple / violet	7
Grey	8
White	9

Examples

I	II	III	Value
Yellow	Purple	Orange	47 000 (47k)
Brown	Black	Yellow	10 0000 (100k)
Brown	Black	Black	10 —— (10R)
Black	Brown	Black	01 —— (1RO)

TABLE 4. Colour code, used to show values of resistance, capacitance or voltage.

COLOUR CODING

Because of the use of preferred values and multiples, we need only three figures to specify the value of a resistor, two figures for the preferred value and one to indicate what multiplier is used. These are coded on to the body of the resistor, using the colour code shown in Table 4. The colours are arranged in bands round the body of the resistor, starting at one end with the first figure of the preferred value, called the first significant figure. The second coloured band then indicates the second figure of the preferred value (second significant figure) and the third band shows what multiplier is being used: the number of zeros after the second significant figure. A fourth band, silver for 10%, gold for 5%, is sometimes used to show the tolerance value when this is closer then 20%, but not all manufacturers use the tolerance band.

MEASURING INSTRUMENTS

The 'multimeter' is the most commonly used measuring instrument for electronics work. It consists of a meter dial with switching arranged so that several ranges of voltage, DC or AC (RMS), DC current and resistance can be measured. The resistance range is used mainly for checking that a circuit is continuous (continuity checking), and for measuring the values of resistors, but the voltage scales are the most widely used scales, particularly DC voltage ranges.

To make a reading of voltage at a point in the circuit, the negative socket of the meter is connected to the negative supply lead, and the positive socket of the meter to the point whose voltage is to be measured. What we are reading in this way is the voltage between the point and supply negative. The meter is then set to a suitable voltage range, greater than the supply voltage, and the circuit switched on. The reading is then taken, making sure that the correct scale on the dial is being used. If the meter reading is too near zero to be read with any accuracy, a lower voltage range can be switched in. Never start with a low voltage range, and never leave the meter switched to a current range. The meter operates by passing some current from the circuit through a coil of fine wire (the moving coil), and too great a current can overheat and damage the coil. Connecting the meter to a high voltage when it is switched to a low voltage range, or connecting to almost any voltage when it is switched to a current range will cause too much current to flow. The safest setting, if no OFF position is provided, is the highest voltage range.

DC voltage readings can be taken quickly, and can be a useful guide to the 'health' of a circuit, since many circuit diagrams show the normal voltages that can be expected at several points in the circuit. The readings can sometimes be misleading, however. The meter takes some current from the circuit, and the current has to pass through the resistance of the circuit, so that extra current flows. By Ohm's law, there must be greater voltage drops across the resistors, so that the voltages are not the same as they were before the meter was connected. This is not a fault of the meter — it reads as accurately as it can the voltage that is present when it is connected, but it cannot read what the voltage *was* when it was not connected.

The cure for this is to be certain that the resistance of the meter is much higher (ten times at least) than the resistance in the circuit connected across the meter. The resistance of the meter is found by multiplying the range value by the figure of ohms-per-volt for the meter. For example, using a 10 k/V meter on the 10 V range, the meter resistance is 10 × 10 = 100 k, and the voltage readings will be unreliable when we are taking readings in circuits where resistances of 10 k or more are used. One solution to this problem is to take current measurements in circuits that cause difficulty, but this involves breaking the circuit and connecting the multimeter leads, with the multimeter set to a current range, in the gap in the circuit. The most satisfactory solution is to use a multimeter of at least 20 k/V and to avoid readings at awkward parts of the circuit.

THE OSCILLOSCOPE OR CRO

The CRO is the most useful single electronic measuring instrument, since it can be used to measure voltage (AC or DC), the time of one cycle of a wave, and also to show the shape of a waveform. In its normal use, the oscilloscope negative lead is connected to the supply negative ('earth' or 'ground') of the circuit being tested, and the oscilloscope + or 'signal' lead is connected to the point in the circuit where we want to take measurements. With the CRO switched on, a horizontal line of light appears on the screen. The line is caused by a spot of light moving at a steady speed from left to right, retracing rapidly, then repeating the trace. We can adjust the speed at which the spot sweeps across the screen. The speed can be varied from very slow, perhaps 0.1 seconds for 1 cm, to very fast, 1 uS or less for 1 cm. This is called 'timebase' control.

A signal voltage applied at the input will cause the spot of light to be deflected vertically, up and down. If we set the timebase switch to OFF, or to its slowest

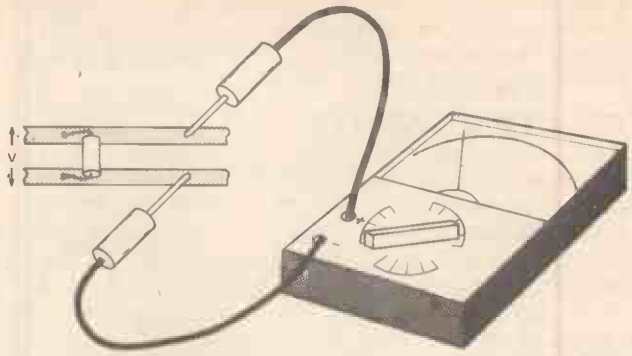


Fig. 10. A voltage measurement. The leads of the voltmeter are connected between the points where voltage is to be measured.

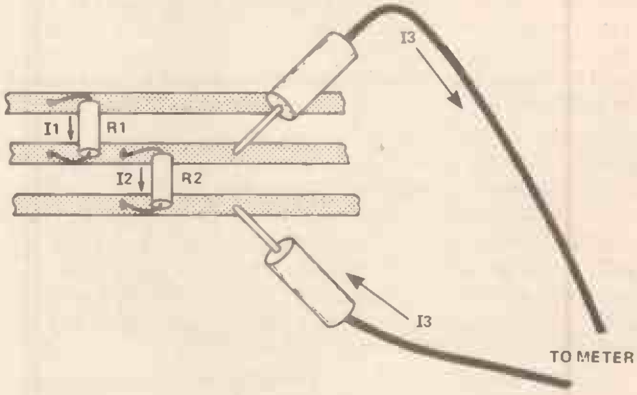


Fig. 11. Errors caused by a voltmeter. The current flowing through R1 must split, some going through R2, some through the meter. More current is being drawn through R1 now than when the meter was not present.

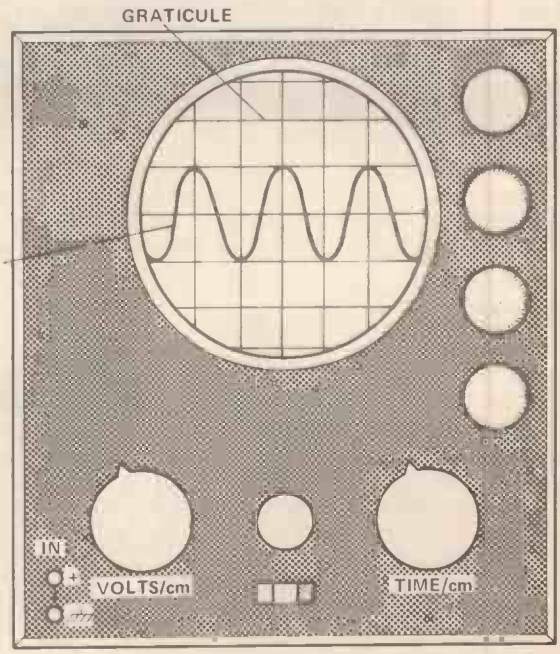


Fig. 12. The front panel of the CRO with the important operating controls labelled. The other controls are used for setting up.

position, we can see the effect of the vertical deflection by itself. The amount of vertical deflection is a measure of the amplitude, in volts peak-to-peak, of the wave. The

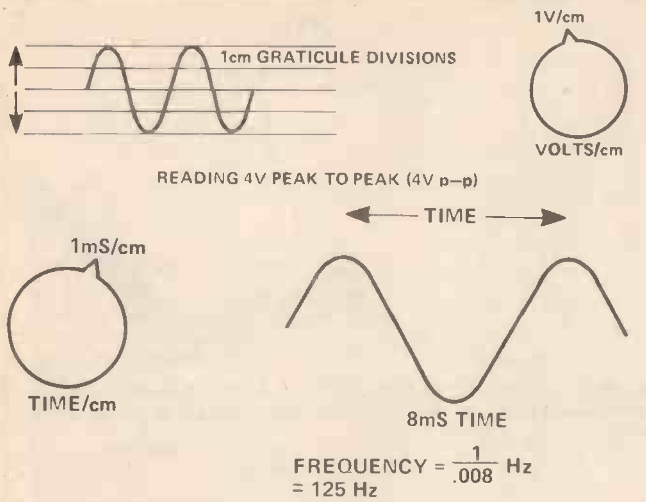


Fig. 13. Measuring the voltage and frequency of waveforms using the CRO.

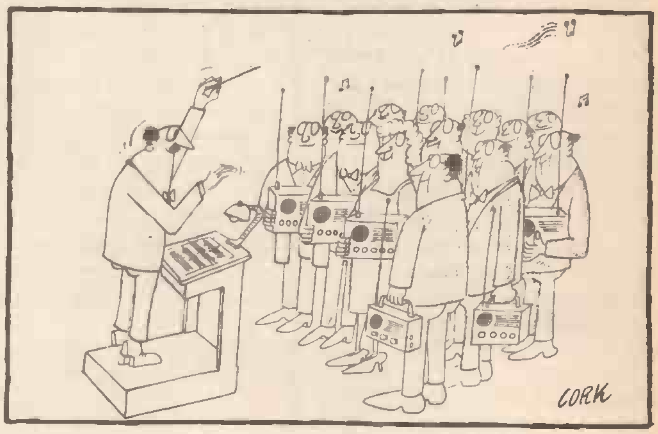
calibration in volts/cm is shown on the input sensitivity switch. To find the peak-to-peak amplitude of a waveform, we measure the vertical distance in centimetres from peak to peak on the screen, then multiply this reading by the setting in V/cm on the Y-sensitivity switch. For example, if the waveform measures 4 cm vertically, and the setting of the switch is 0V5 V/cm, then the peak-to-peak voltage of the wave is 4 × 0.5 = 2V0.

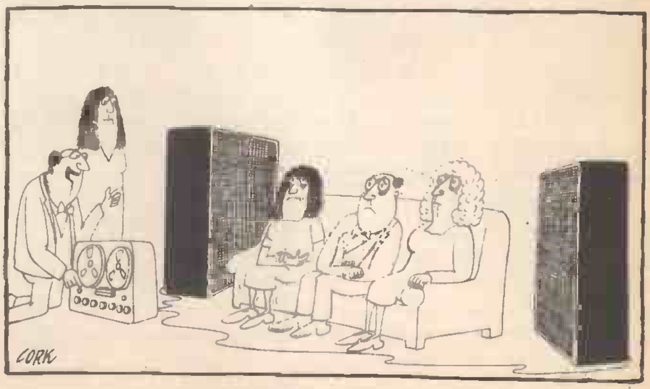
With a waveform input, starting the timebase will cause the spot of light (the trace) to draw a graph of waveform voltage plotted against time. The shape on the screen is the waveshape, and we can measure its amplitude. The time of one wave can be measured by noting the distance in centimetres, horizontally, from one peak to the next, and then multiplying by the setting of the TIME/CM switch. For example, if the distance horizontally between peaks is 3 cm, and the TIME/CM switch setting is 10uS/cm, the time between peaks is 3 X 10uS which is 30uS. The frequency of this wave is 1/time, which is 1/30 X 10^{-6} or 10^{-6}/3 033 333Hz.

This is, of course, only a skeleton outline of the use of the CRO, so that the reader can understand how we know the shapes of the waves we use in electronics, and how we measure such quantities as wave voltage and frequency. For more information on this fascinating instrument, consult THE OSCILLOSCOPE IN USE, from the book service (see ad in this issue). HE

In Part 2:

Ian Sinclair explains the theory and practice of capacitors and inductors and goes on to explain resonant circuits and their uses. He also introduces the standard symbols used in circuit diagrams and gives some hints on the practicalities of construction.





'And now a train crash, also in stereo.'

Stereo Amplifier

Start to build up your stereo system with this easy to build amplifier. With an output of 4 watts per channel it is suitable for use in most small rooms — ideal for the den or bedroom.

MUSIC IS THE food of love, or perhaps, one man's music is another man's passion. Until recently however the system used to reproduce this vehicle of love or passion was a Radiogram of, shall we say, dubious quality. Musical melodies were often as not accompanied by a series of squarks, clicks and an ever-present hum.

Nowadays however the situation is different with the widespread availability of good quality systems at a reasonable price. The majority of Hi-Fi systems in use today are made up for a number of seperate units, from pick up and deck through amplifier to speakers. The Hi-Fi chain of reproduction, like any other chain, is only as strong as its weakest link. Fortunately there is a wide range of choice when it comes to selecting any piece of equipment but perhaps the area in which the choice is most apparent is the amplifier.

The Hobit offers a low cost amplifier that can form the basis of a good Hi-Fi system that will not break the bank. Its power output is not vast at a little over four watts per channel, but it will fill many a room with the volume full up. The Hobit provides all the usual controls, volume, bass, treble and balance as well as having facilities for

Specifications

Power output 4 watts into 8 ohms (per channel)
8 watts into 4 ohms

Signal to noise ratio > 60 dB

Distortion less than 0.5% (at 4 watts, 1 kHz)

Frequency response 30 Hz to 16 kHz

Input Impedance > 47k

Sensitivity	Pick Up 5 mV
	Tuner 100 mV
	Aux 200 mV
	Tape 100 mV

Suitable for use with magnetic cartridges.

coping with up to four inputs, tuner, tape, radio and a magnetic pick-up. The amplifier also has a tape output socket. All inputs and outputs are brought to a group of phono sockets at the back of the Hobit.

Speaker connections are also fitted to the back panel of the amplifier. The headphone output is taken to a jack socket that is mounted above the speaker output terminals.

CONSTRUCTION

The Hobit was designed with ease of construction in mind and for this reason all the potentiometers and switches have been mounted on the single PCB of the amplifier. This greatly reduces the amount of interwiring necessary during construction and hence the likelihood of mistakes arising.

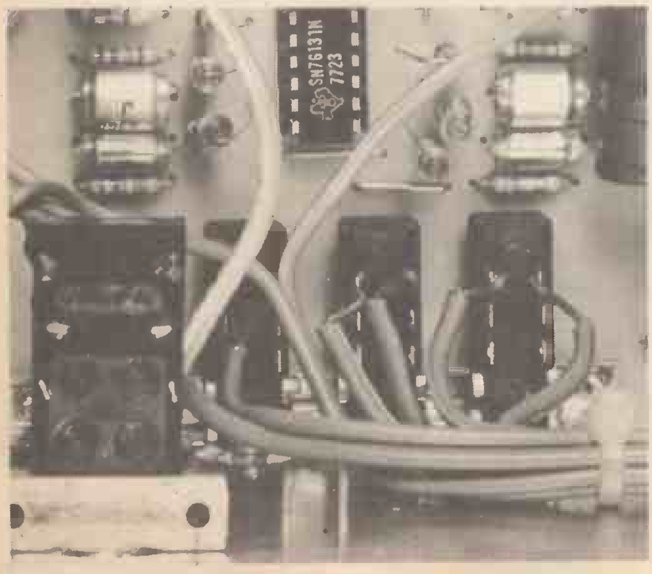
Assemble components according to the amplifier's overlay, fitting the resistors and capacitors first, followed by IC1 (use a socket for this device) and BR1, mount the pots last.

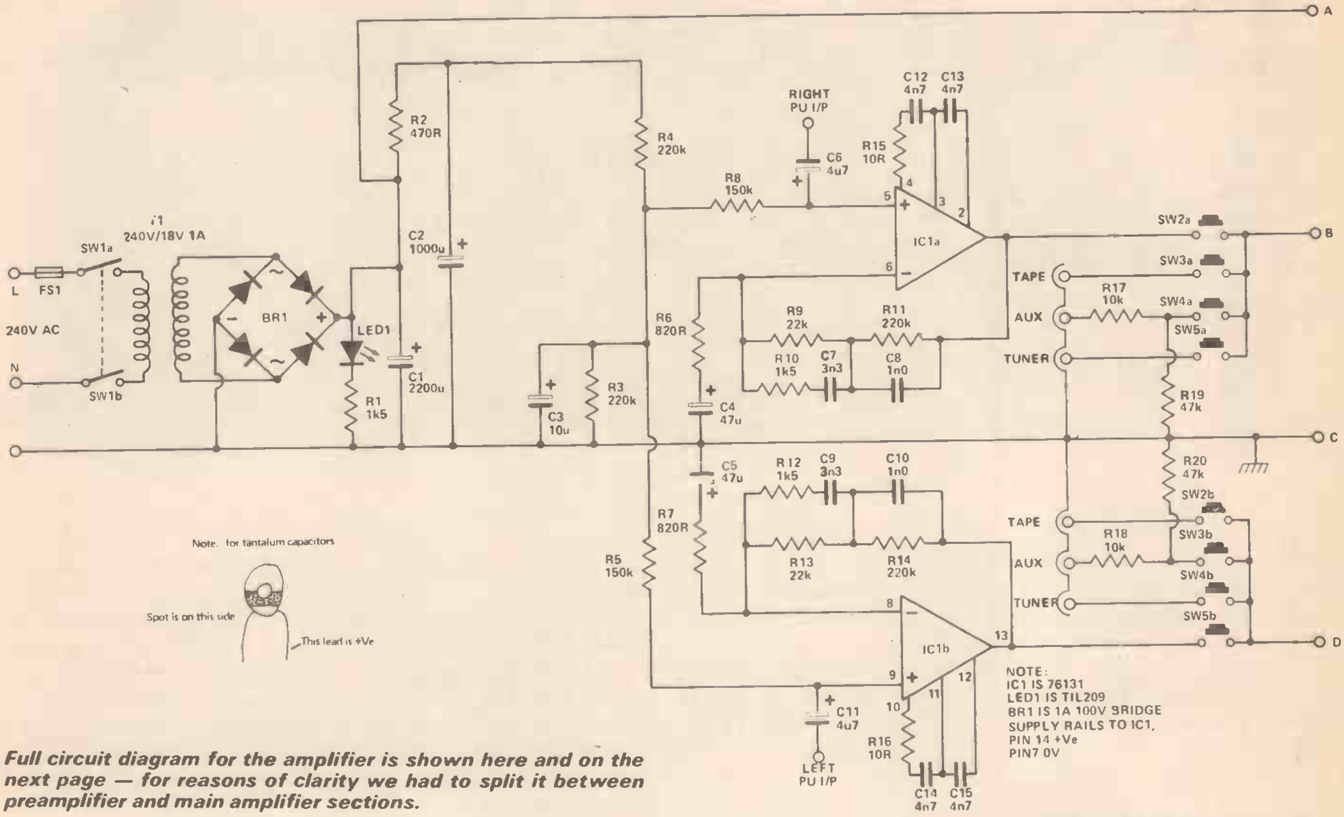
With the board at this stage it's time to prepare the case. Offer up the PCB to the front panel and mark out the holes for the potentiometers. The pictures of the amplifier show the arrangement for the heatsinks necessary for ICs 2 and 3. The photo of the completed Hobit shows the general layout of all the major components and fitting the rest of the parts should be straightforward.

When construction work is complete, check the amplifier very carefully. In particular check for solder splashes on the PCB or for components fitted the wrong way round.

When you are sure all is well, connect up a pair of speakers, make sure the phasing is correct (positive of the speaker to the amplifier output and negative to chassis), and turn on. Plug in your record player, turn up the volume and listen to your favourite songs of love courtesy of our Hobit.

The two photographs below show the earthing arrangement used on the prototype. On the left can be seen the switch ends of the screened cable, note that the outer braid is not connected to anything. The right hand photograph shows the input sockets — the outer braid is connected to the chassis at each socket, this system is used to avoid possible 'hum loops.' Input attenuation resistors can be seen connected to the Aux input socket in the right hand photograph.





Full circuit diagram for the amplifier is shown here and on the next page — for reasons of clarity we had to split it between preamplifier and main amplifier sections.

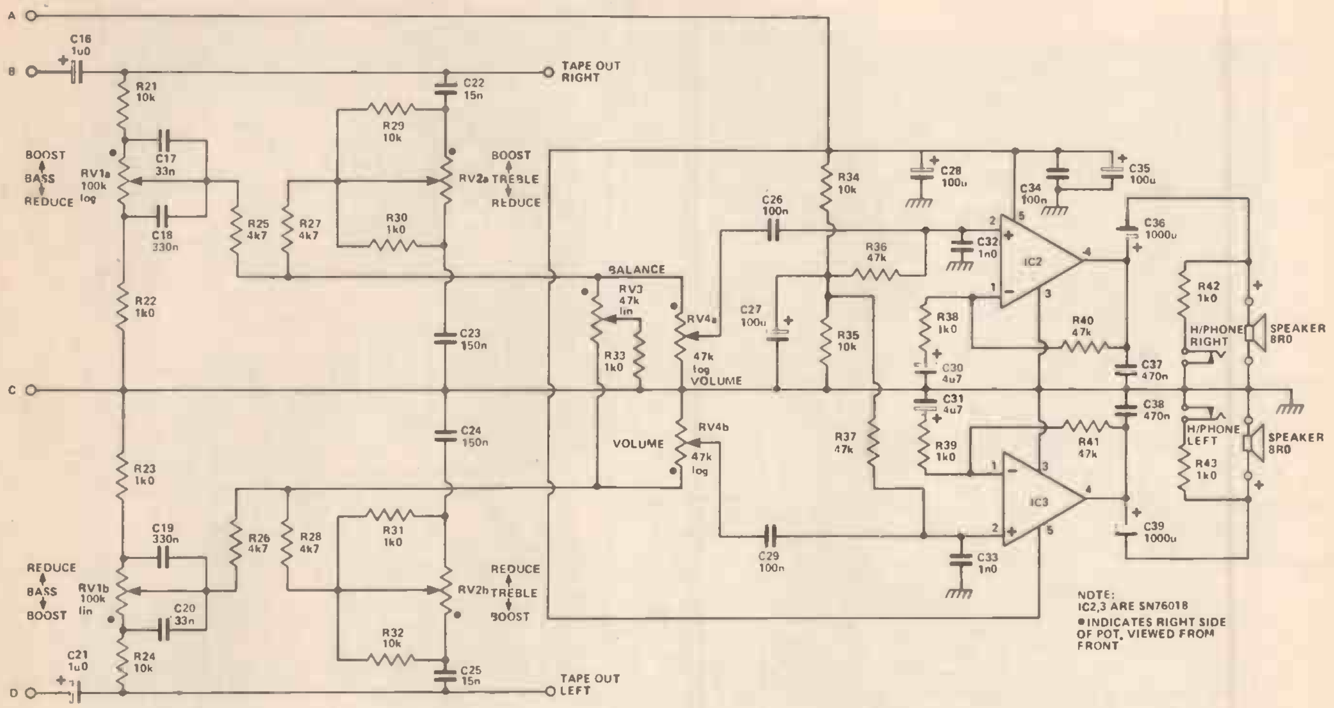
POWER SUPPLY

The power supply's job is to convert the 240 volt AC mains output into a low voltage DC supply that is required by the amplifier's electronics.

T1 steps the mains voltage down while the bridge rectifier BR1 takes care of converting the resulting low voltage AC supply into the DC amplifier supply. C1 provides smoothing for the DC rail, while LED1 with associated current limiting resistor R1 indicates that the power supply is on. Power to the output stages is taken directly from C1 while that to the preamplifier is taken, via R2, to a further smoothing capacitor C2.

PREAMPLIFIER

Any amplifier, and the Hobit is no exception, must be expected to deal with a wide variety of inputs. The level and charactersistics of inputs can vary widely. It is the job of the preamplifier and tone control sections to bring all signals to the same level and balance so that they may be fed to the power amplifier whose job is just to drive the speakers.



How it Works

The Hobit is provided with four inputs: TAPE, AUX, TUNER and PU (or Pick Up). Of these inputs Tape and Tuner are assumed to be of roughly the same level (many recorders and tuners have output level controls so that their outputs can be adjusted to suit any amplifier) the Aux input has an attenuator, formed by R17(R18) and R19(R20). This reduces the sensitivity of this input with respect to the tape and tuner inputs.

The fourth input is the pick up. The output from a modern pick up is at a very low level and some circuitry to bring it up to the level of the other inputs must be provided. In addition, manufacturers of records, for various reasons, do not record records with a flat frequency response. Instead they boost the high frequency notes with respect to the mid range notes and cut the bass notes. On playing a record we must take this recording characteristic into account, and boost the bass and cut the treble (one of the advantages of adopting this system should now become apparant, for if we cut the treble when playing a record any surface noise and scratches will be reduced in level as well).

IC1a and b and their associated feedback networks provide the necessary replay characteristics and gain.

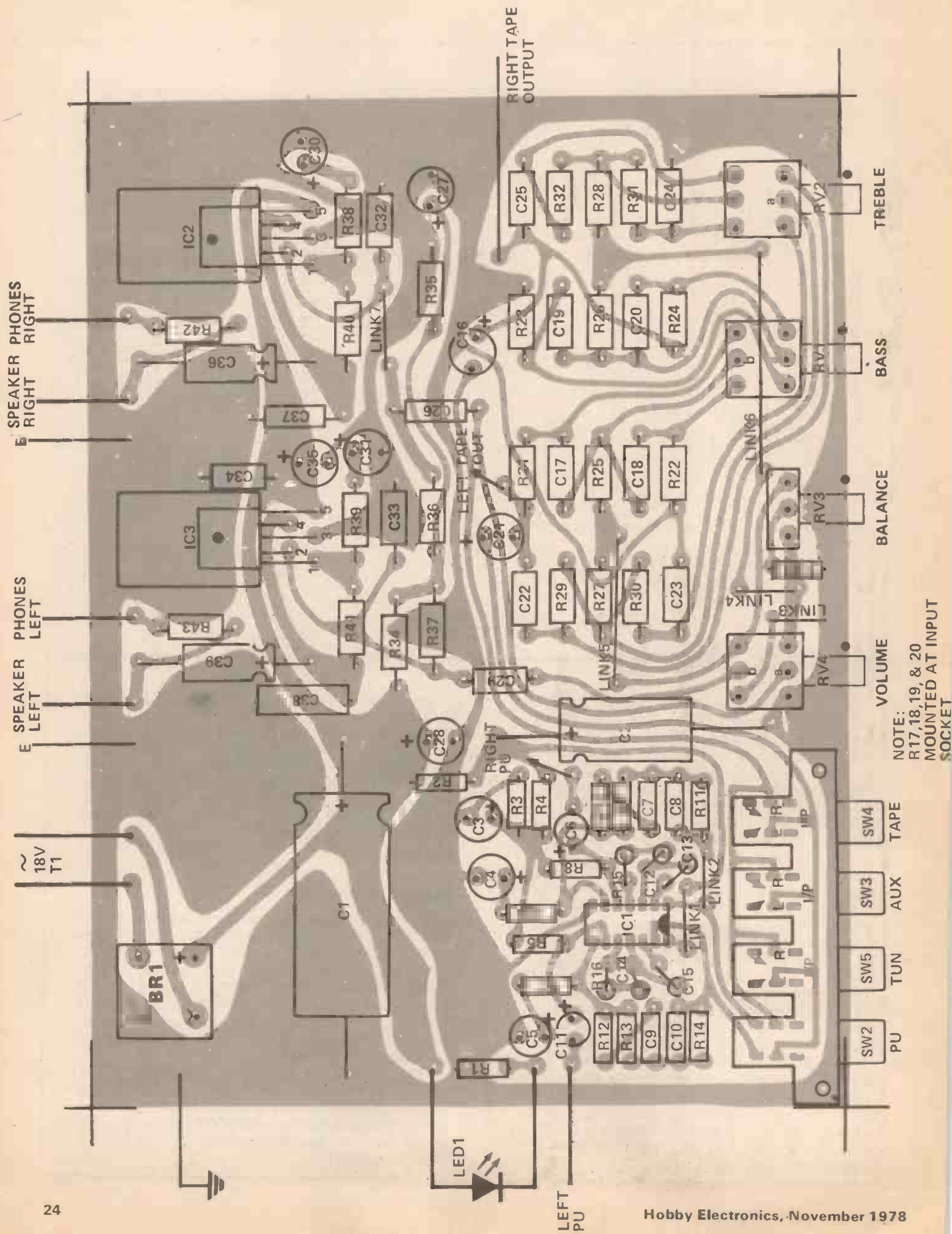
Switches SW2-5 select the required output and pass it to the tone control stage. This is a Baxandall passive circuit giving approximately 10dB of boost and cut at 100 Hz and 10 kHz. RV1 is the bass control and RV2 is the treble control.

The outputs of the tone controls are fed to the balance control RV3 and thence to the volume controls RV4. From here the signals are passed to the power output stages.

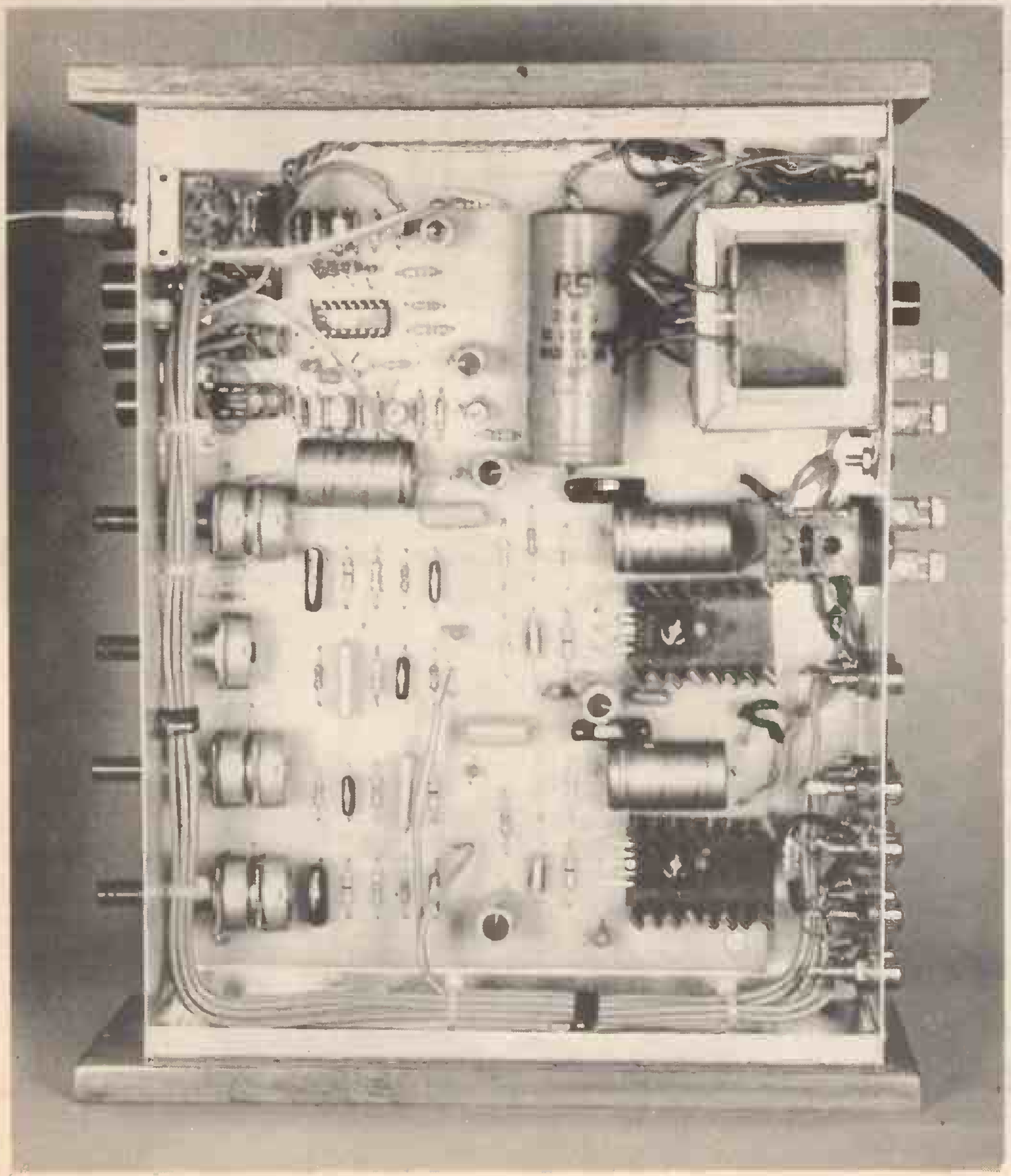
POWER AMPLIFIER

The power output stages are formed by ICs 2 and 3. The components around these devices are to ensure that they remain stable under all operating conditions. The gain of the output stages is set by R24(R43), R40(R41) and C30(C31). Power to the devices is taken from C1 and from a half supply bias line provided by R34(R37), R35(R36), R38(R39) and smoothed by C27(C28).

The outputs are taken via C36(C39) to the output terminals of the Hobit and so to the loudspeakers. The headphone outputs are fed from the series resistors R44(R45) to reduce the signal level to an appropriate level for most headphones.


RIGHT TAPE OUTPUT
TREBLE
BASS
BALANCE
VOLUME
NOTE: R17,18,19, & 20 MOUNTED AT INPUT SOCKET
TAPE
AUX
TUN
PU
SW4
SW3
SW5
SW2
PHONES RIGHT
SPEAKER RIGHT
PHONES LEFT
SPEAKER LEFT
E
~ 18V T1
BR1
C1
IC1
IC2
IC3
LEFT TAPE OUT
RIGHT PU
LED1
LEFT PU
LINK1
LINK2
LINK3
LINK4
LINK5
LINK6
LINK7
RV1
RV2
RV3
RV4

Component positioning on the PCB can be seen clearly above, for values of each component refer to the Parts List. Below is a general view of the completed prototype, if in doubt about what any component should look like you can check with the photograph. Premade boards will be available from some advertisers in the magazine.



Parts List

Approximate cost: £20

RESISTORS (all ¼W 5%)	
R1, 10, 12	1k5
R2	470R
R3, 4, 11, 14	220k
R5, 8	150k
R6, 7	820R
R9, 13	22k
R15, 16	10R
R17, 18, 21, 24, 29, 32, 34, 35,	10k
R19, 20, 36	47k
R22, 23, 30, 31, 33, 38, 39 42, 43	1k0
R25, 26, 27, 28	4k7
CAPACITORS	
C1	2 200u 63 V electrolytic
C2, 36, 39	1 000u 63 V electrolytic
C3	10u 16V electrolytic
C4, 5	47u 16 V electrolytic
C6, 11, 30, 31	4u7 35 V tantalum
C7, 9	3n3 polystyrene
C8, 10, 32, 33	1n0 polystyrene
C12, 13, 14, 15	4n7 polyester
C16, 21	1u0 35 V tantalum
C17, 20	33n polyester
C18, 19	330n polyester
C22, 25	15n polyester
C23, 24	150n
C26, 29, 34	100n polyester
C27, 28, 35	100u 32V electrolytic
C37,38	470n polyester
SEMICONDUCTORS	
IC1	SN76131
IC2, 3	SN76018
LED1	TIL209
BR1	100V 1 A

MISCELLANEOUS
PCB as pattern, case, knobs, fuse plus holder, phono sockets, screened cable

The majority of parts will be available from most mail order firms advertising in Hobby Electronics. If you have difficulty in obtaining the SN76131 and SN76018's they can be obtained direct from Texas Instruments Ltd., 186 High Street Slough, Berkshire for £6.31 inclusive. The case came from Maplin and the PCB mounting potentiometers are stocked by Electrovalue — see their catalogues for details.

The printed circuit board pattern shown here is the correct size. This can be copied either photographically or manually. However this and other PCBs should be available from advertisers in Hobby Electronics and next month we shall be giving details of Hobbiprints, a simple dry transfer method of making your own PCBs'.

The Edison Effect

Thomas Edison was one of that rare breed — the practical inventor. He holds the US record for the number of patents filed but one of his discoveries, the diode, was not appreciated by him, or anyone else for the matter, at the time.

Many famous discoveries were made by accident or whilst investigating another field. The Edison Effect falls into this category. K. T. Wilson tells the story . . .

THOMAS ALVA EDISON (1847-1931) was called *"The Wizard who Spat on the Floor."* The U.S. Patent Office credits him with more patents on inventions than any other U.S. citizen before or since and it was he who coined the expression *'genius is 1% inspiration, 99% perspiration.'* What it all amounts to is that even though Edison was a practical man, he was also an inventive genius. This is the story of how he discovered one of the basic principles of electronics — and then forgot it!

LET THERE BE LIGHT

In 1878, Edison, then aged 31, along with his partner Swan, produced the first successful incandescent light bulb. That's the type of lamp bulb that we use today with a wire filament heated white-hot by electric current. It's difficult to imagine, writing this a century later, how astonishing this must have been, to have light at the touch of a switch. These early bulbs used filaments which were either of carbon, produced by charring silk or cotton threads, or of tungsten (a hard, tough metal) wire. The filaments were sealed into a glass bulb, with the wire leads made of a material which expanded to the same extent as the glass so that the glass around the wire did not crack as it all cooled. The bulbs were then evacuated, using a rather primitive air pump. The vacuum was necessary because the oxygen in the air combines with any very hot metal (or carbon) — the material, in other words, burns. Take away the air, and the filament can be heated white hot without burning. They had their problems, of course; the carbon filaments were very fragile and easily broken but astonishingly enough, a few carbon-filament lamps have survived and are still usable. Edison, however, felt that the future lay with the more robust metal filaments.

Now in those days, as now, you could arouse a lot of interest with a new invention, but it had to be pretty well sorted out before people in large numbers could be persuaded to buy. The metal-filament bulb certainly had a better chance of getting to the customer in one piece, but its working life was short. After only a few hours of running, the light level had dropped noticeably, the glass of the bulb darkened, and soon afterwards the filament melted.

At that particular time, what we now call vacuum physics was in its infancy, and very little was known about how materials behaved in a vacuum but nowadays, we can understand perfectly what was happening in these primitive light bulbs. Every substance has its own vapour around it and the pressure of this vapour can be measured. When the pressure of the vapour equals the pressure of the atmosphere around the material, the material vaporises rapidly, we say that it *boils*. The higher the temperature of any material, the greater is its vapour pressure.

LOW PRESSURE PROBLEMS

At 20°C (normal room temperature) for example, the vapour pressure of water is 2.34 kPa (the kilo-Pascal, shortened to kPa, is the unit of pressure), and at 100°C, the vapour pressure of water is 101.32 kPa, equal to the pressure of the air about us, so that water boils at 100°C. If we put some water in a container inside a vacuum bell-jar and start to pump out the air, however, we can soon bring the air pressure inside the jar to 2.34 kPa. This is the same as the pressure of vapour around water at 20°C, so that the water inside the bell-jar will boil at this pressure, even though its temperature is only 20°C. By lowering the pressure still further, we can make the water boil even while it is busy turning into ice.

What has this to do with lamp bulbs? Well, it's just that Edison's tungsten filaments, at the temperature that was needed to give out light (well over 2000°C) had a vapour pressure which was pretty close to the pressure inside the glass bulb — so the tungsten was evaporating fast. Like any other vapour, whenever the tungsten vapour hit the cold surface of the glass it condensed, leaving a thin film of tungsten on the glass. This cut down the amount of light passing through the glass and also reflected a lot of the radiated heat back. As more and more tungsten condensed, less light was given out, and more heat was reflected, making the filament hotter so that it evaporated faster. Eventually, the inevitable happened, the filament melted.

Edison was strictly a practical man, self-educated, who had no interest in science unless he could see an answer to a problem. This was such a problem, and he

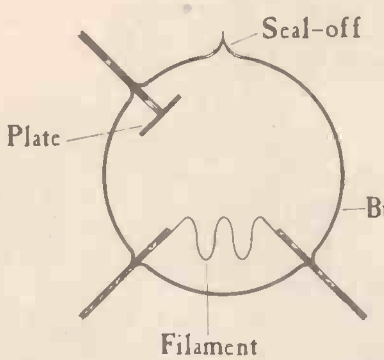


Fig. 1 **Edison's experiment which he set up to see if a charged plate inside his light bulb would attract the vapourised tungsten which was causing all the problems.**

browsed over some ideas. The most likely connection he could see was with electrostatics. He reasoned that the hot filament was giving off some sort of particles and that it was these landing on the glass which were causing the trouble. What could be done? According to the laws of Electrostatics, charged particles could be attracted or repelled by other charges, were the particles charged? Edison wasn't interested in speculating, he simply wanted a solution to the problem, so he devised an experiment to see if he was right.

PHYSICAL ATTRACTIONS

If the particles were charged, it should be possible to attract them to a metal plate inside the bulb if the metal plate were connected to a DC supply. Edison reckoned that if the particles could be attracted to a plate, they would not fog the glass and the Edison light bulb would shine for much longer. In addition, it would be one in the eye for Swan and his carbon filaments.

Using his excellent workshop facilities (which have been preserved as a museum), he constructed his experimental light bulb, looking something like Fig. 1. The metal plate was connected to a stub of wire which was in turn sealed through the glass, and the rest of the bulb was a normal lamp-bulb which was then evacuated and sealed-off in the usual way.

Edison then set up the circuit for his experiment. The lamp filament was operated by a DC supply, and another DC supply was hooked up for the plate. How would he know if it worked? The obvious answer was to wait and see if the bulb dimmed, but Edison was much too impatient for this. He decided that if charged particles reached the plate, then an electric current would flow, and that this current could be measured. He connected a milliammeter into the supply line for the plate and fixed up a reversing switch so that one side of the supply could be connected to the plate and the other to the negative filament lead (Fig. 2).

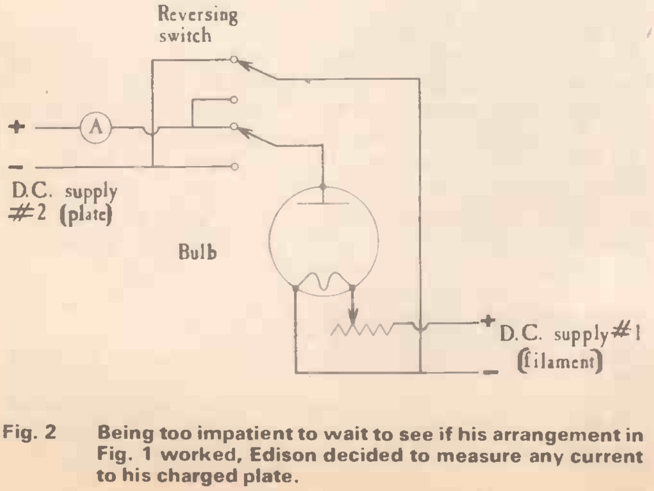


Fig. 2 **Being too impatient to wait to see if his arrangement in Fig. 1 worked, Edison decided to measure any current to his charged plate.**

He switched on and juggled with the controls. To his delight, he found that the milliammeter registered a current when the plate was positive with respect to the filament but not when the plate was negative with respect to the filament. This was clear evidence that charged particles were moving through the vacuum inside the bulb. He then tried varying the filament current. When the filament current was decreased, the milliammeter current (plate current) dropped greatly, and became zero when the filament was no longer glowing brilliantly, though still glowing. This was equally clear evidence that the charged particles were coming from the filament and that they were emitted only when the filament was very hot. Since they collected on a positively charged plate, the particles must be negatively charged.

It looked good to Edison and he then set about what we would call a life-test, adjusting the filament current to its normal value, and making the plate voltage positive so that the charged particles were attracted to the plate. He then turned to something else, since he always had several projects going at the same time.

MEANWHILE, BACK AT THE LAB

He returned to his bulb experiment a few days later to find the plate current still flowing merrily but the bulb clouding over in the usual familiar way. Soon afterwards, the filament melted. Edison, not quite believing it, made a second sample. He found the same action, the flow of current in the plate circuit indicating that charged particles from the filament were landing on the plate. This bulb also clouded over and then failed. Edison hated being beaten, but he didn't know what to do next. It was obvious that the clouding of the glass was not related to the flow of the charged particles. Being a shrewd man, Edison thought that he should patent the idea, just in case he thought of a use for it later. So it was that the Edison Effect was described fully in its US patent, filed in 1880. Edison was soon too busy with ideas to revive his experiments and, tragically, no-one who might have made use of the idea seems to have read the patent — there were no instant copiers in those days.

What Edison had invented, you see, was the first diode valve. With the invention of the telephone in 1876, and Marconi's first long-distance radio transmission of over a mile in 1895, the time was ripe for the birth of electronics. Poulsen in Denmark was experimenting with magnetic recording, a principle that cried out for electronic amplification; but the Edison effect was forgotten by its inventor, overlooked by the rest of the world, and the patent lapsed. Later on, Fleming had to invent the diode all over again and Irving Langmuir was then ready to add the grid that made the diode into a triode, opening the way to amplification.

The lamp-bulb problem? Swan was more of a scientist than Edison, and he soon realised that the problem was caused by the low pressure around the filament. The only reason for using such a low pressure was to remove oxygen from the bulb, and Swan devised the method that is still in use today, of allowing an inert gas (one which does not allow hot metals to burn) into the bulb

The Edison Effect

after the air was evacuated out. Such gas, argon or neon, can have a fairly high pressure, so that the rate of vaporisation of the metal is very low and can help to conduct heat away from the hot filament.

IF ONLY . . . .

What a lot of might-have-beens we can think up, though. Suppose, for example, that the remarkable genius Heinrich Hertz, born in 1857, who discovered radio waves, but who died at the age of 37, had noticed the Edison effect? What sort of history would have been written, what sort of electronics would we know today?

Anyone out there forgotten about any old inventions?

HE

Digital Clock

Pass some time with this timely project! Using only the minimum of components you can construct our multipurpose digital clock.

THIS IS NOT SO much a project, more a way of showing just one way of using a particular module. The module we have chosen is available as the RS 307-402 from virtually any component supplier, or they can order it for you.

The module is a ready made printed circuit board, with all the active components soldered in place. Components include the main logic device, the light emitting diode (LED) display and all the capacitors, transistors, diodes and resistors needed to produce a digital clock. All that is required, besides the module, is a special transformer, some switches, a small loudspeaker and case. With the addition of a PP3 type battery and one variable resistor, the clock will keep time even during winter power failures.

TAKE YOUR CHOICE

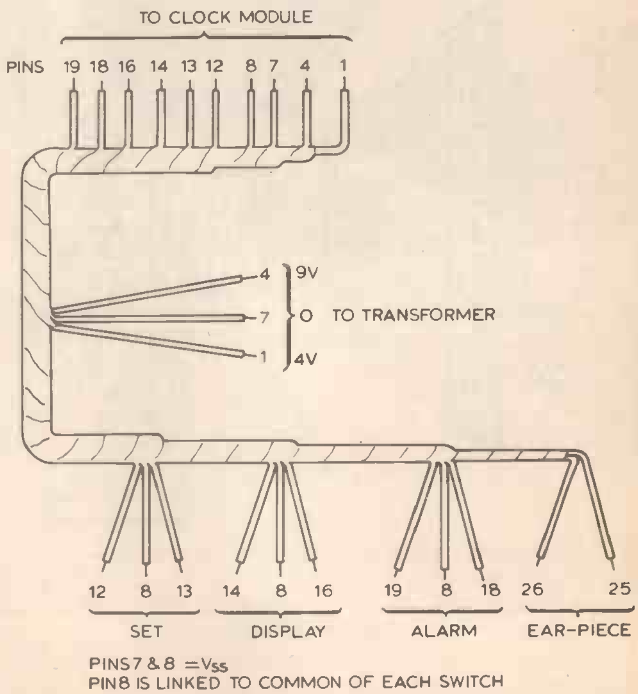
The module has been designed to be as useful as possible, to as many people as possible — as a result it becomes a major effort to decide which features to actually use in a real clock. For the HE prototype we tried to keep it as straight-forward as possible with just time and alarm. Features that we opted not to use include power failure back-up, display brightness control and timer, however the constructor with a little experience can obtain full data sheets and 'soup up' the basic HE clock as required.

CONSTRUCTION

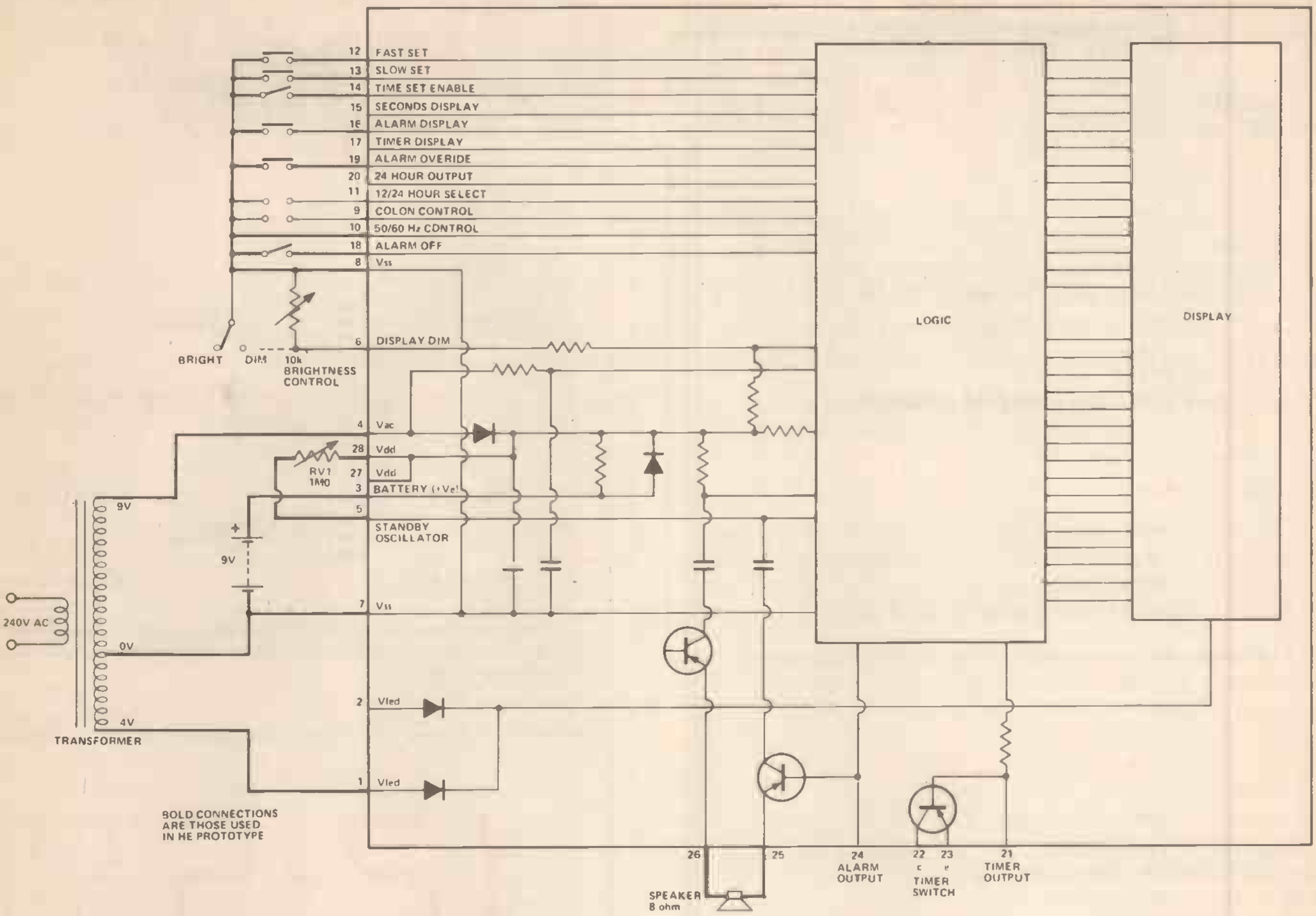
The case we picked was just big enough for the mains transformer and module, a good point was that the front was precut to accept the display. The main wiring is from the module to the function switches and transformer, plus the mains lead to the transformer. Make sure that the green/yellow earth lead is connected to the metal casing.

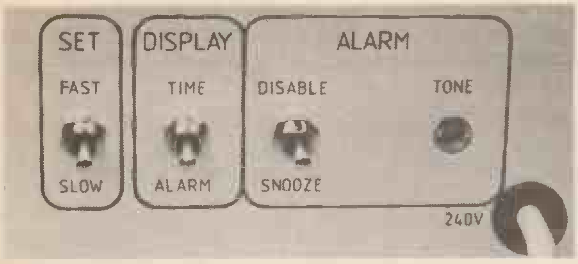
The first stage was to drill the case for the switches, mains lead and transformer mounting. Next the wire loom can be made up, the one illustrated can be modofied if extra facilities (and more switches) are used. RV1 the 1 Meg. preset is connected between pins 5 and 28 of the module, with the aid of a flying lead from its centre connection.

The standby battery is connected with a standard battery clip, between pins 3 and 7. The alarm loud speaker can be any device with an impedance of more than 8 ohms, we used an earpiece in our prototype. Take great care to ensure that the mains cannot touch any exposed metalwork or circuitry. Also use some insulation tape to cover any exposed circuitry on the module front — otherwise if may short out on the case front.



How we wired up the prototype, if you want you can wire individually and then wrap a wire around the bundle to form a loom.





Above is the schematic for the clock module, the slightly thicker lines are the options we used on the prototype — other facilities can be used also if wired up on your version. On the left is the rear end of the HE prototype, as can be seen we did not have much room to spare for extra switch functions.

How it Works

The module can be regarded as the famous 'black box', you input signals in one form and it converts them into another. The input signal is in fact a 50Hz signal, extracted from the low voltage side of the transformer. This signal is converted into a pulse train, which is then fed into ah electronic counting circuit. The counting section is configured in such a way that it advances the minutes after every 3 000 pulses, the hours after every 180 000 pulses. Rather than try and remember such large numbers the circuit divides by 50 to give seconds, then divides the seconds by 60 for minutes — and the minutes by 60 for hours. Also depending on which way you connect pin 11, it resets to zero or 12.00, to give 24 or 12-hour display format.

The display is driven directly from the circuitry, and uses light emitting diodes to produce the 7-segment format. Additionally, there are timer and alarm outputs available via transistor switches on the module.

If the standby battery is used, a power failure just causes the display to blank, and the LSI device keeps counting. The display section consumes most of the power, without it the PP3 can keep the counters running for up to about six hours. The preset resistor (RV1) is adjusted to give 20Hz at pin 5 for accurate time when on standby.

All switch functions rely on contact (or lack of contact) between the appropriate pin and V_{ss} (the LSI circuits most negative voltage).

Parts List

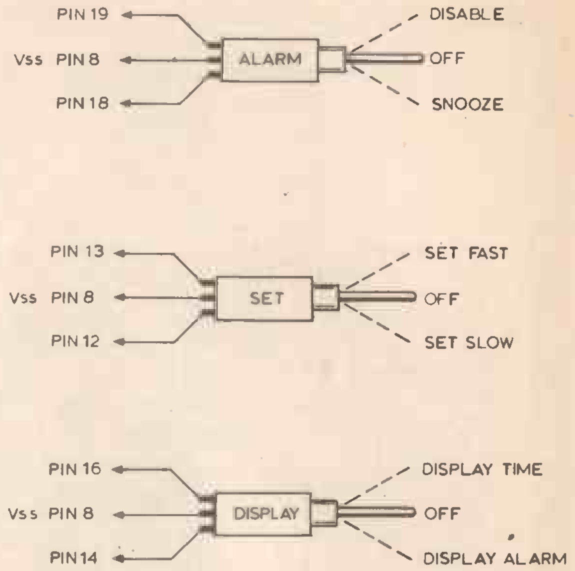
MODULE
RS type 307-402

HARDWARE

2 Single pole double throw (SPDT) toggle switches, with double bias to centre off position.
1 SPDT toggle, with single bias to centre off.
1 Clock module transformer (RS207-778).
1 8 ohm (or greater) loudspeaker.
1 PP3 (rechargeable nickel cadmium) battery with connector.
1 1Meg miniature preset potentiometer.
1 Case to suit (Metac ''Aluminium clockcase'' used in prototype).

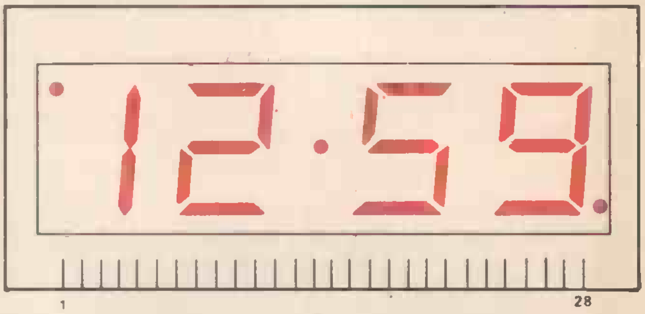
Mains lead etc.

All RS components can be obtained from component retailers to order (if not in stock). The case can be ordered direct from Metac for £2.80 inclusive. **Approximate cost is £16.00.**

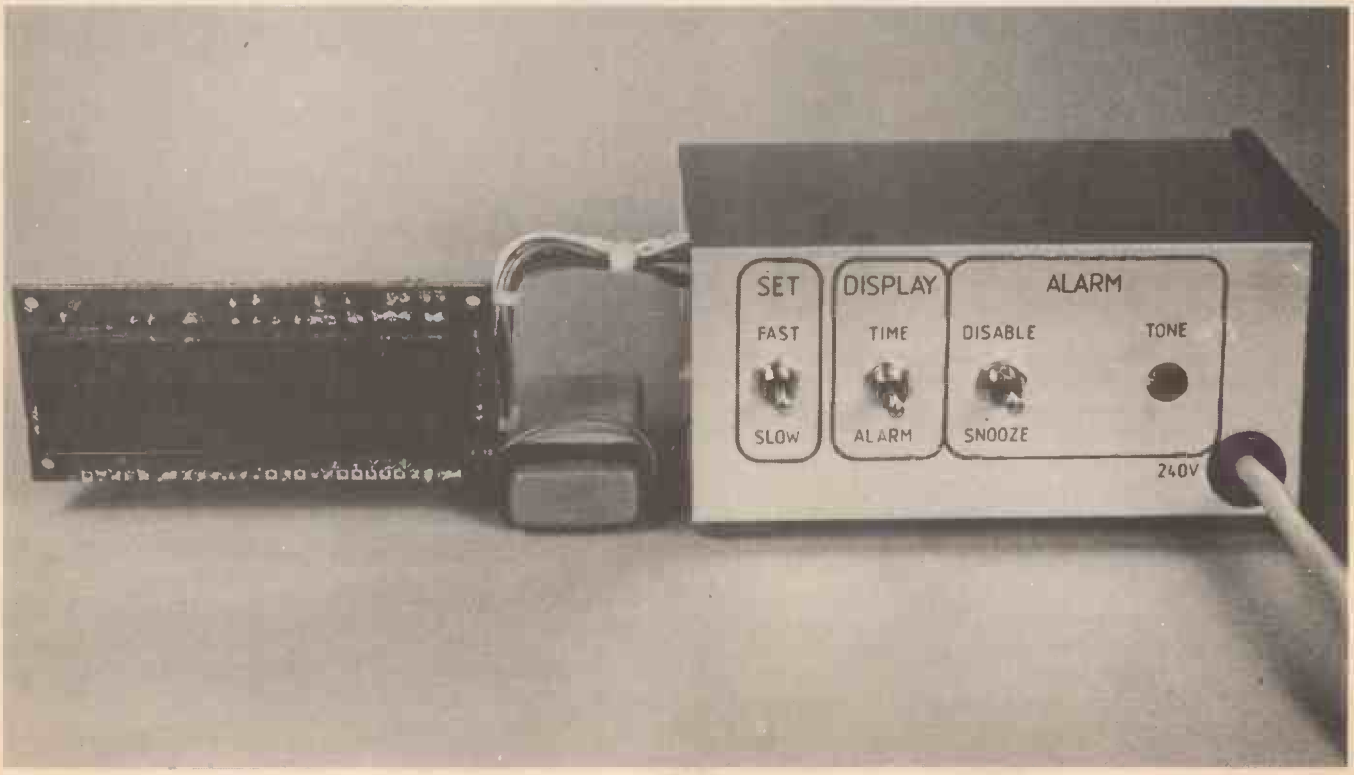


How the three switches are wired up, the display switch is the only one with single bias — towards off from the alarm position.

On the right is a sketch to show which connection is which, the pins are numbered from left to right.



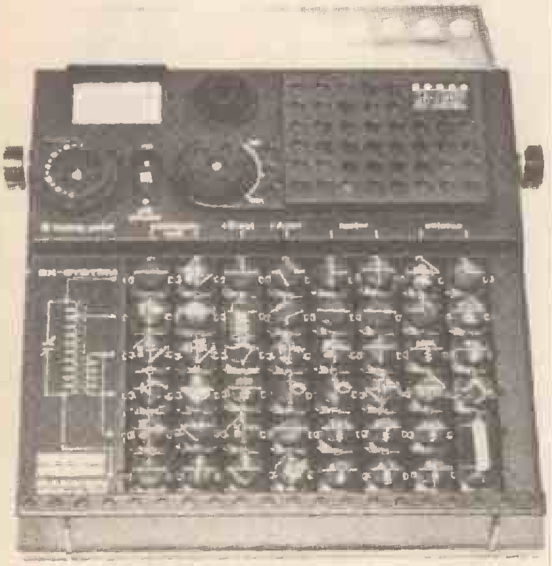
Below is a general 'exploded' view of our prototpye, when fitted inside the case the bottom and top of the module were covered with tape to prevent any circuitry being 'shorted' out.



ELECTRONI-KIT

"EDUCATIONAL KITS OF EXCEPTIONAL QUALITY"

(AUDIO magazine)



THIS IS A POWERFUL RADIO RECEIVER!

The same kit is also 150 other different actual working projects e.g.:

Computer & Logic Circuits
Electronic Organ, Timer, Light Control, Agility Tester, Lie Detector, Siren, Horn, Buzzer, Bird, Metronome.
Cds cell light & sound control
Photogun, Light Oscillator
Light Switch, Light and Sound Morse Code.
Field Strength Meter
Hygrometer, Sphygometer, etc. etc.

Radio Receiver, Transmitter, Amplifier, Audio Generator, Signal Tracer & Injector, Continuity Tester, Telegraph, Photoradio Receiver, Radio Receiver/Microphone Mixer, Illuminometer, Voltmeter, Ammeter, Sound Level Meter, Ohmmeter, Diode & Transistor Tester, Transparency Indicator, etc., etc.

The above is just a *selection* of the circuits available — you can also design your own circuits with these superb new Denshi-Gakken **"EX"** construction kits.

No previous experience of electronics is required but you learn as you construct and have a great deal of fun too. The kits are completely safe for *anyone* to use.

Kits are *complete* with very extensive construction manuals *PLUS* Hamlyn's "All-Colour" 160 page book "Electronics" *(free of charge whilst stocks last).*

ALL KITS ARE FULLY GUARANTEED. Add-on sets (to increase the scope of each kit) are available, plus spares and accessories as required.

150 PROJECT KIT **£39.75**	60 PROJECT KIT **£25.75**
120 PROJECT KIT **£33.75**	30 PROJECT KIT **£18.95**
100 PROJECT KIT **£29.25**	15 PROJECT KIT **£16.75**

Prices include educational manuals, free book, VAT, p&p (in the U.K.) and free introduction to the British Amateur Electronics Club.

Callers at 20 Bride Lane will be very welcome. Trade and Educational enquiries invited.

See us at BREADBOARD '78

Seymour Hall, 21-25 November.

Cheque/P.O./Barclaycard/Access No. (or 1·1p for illustrated literature) to DEPT. HE

ELECTRONI-KIT
20 BRIDE LANE, LUDGATE CIRCUS, LONDON, EC4Y 8DX (01-353 6430)

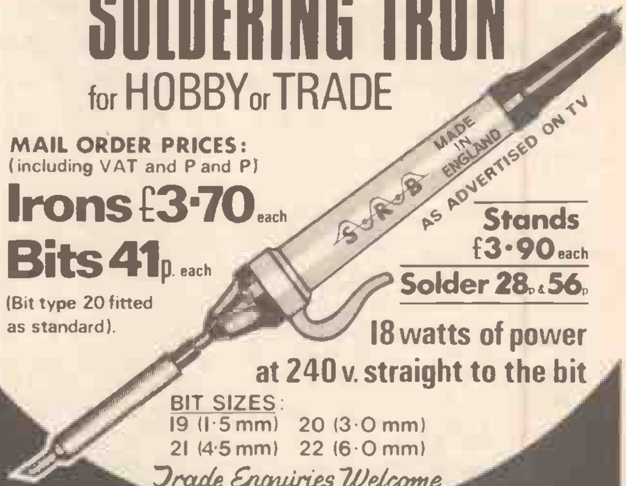
THE IDEAL ANYTIME PRESENT

S·R·B

MINIATURE

SOLDERING IRON

for HOBBY or TRADE



MAIL ORDER PRICES:
(including VAT and P and P)

Irons £3·70 each

Bits 41p. each

(Bit type 20 fitted as standard).

Stands £3·90 each

Solder 28p & 56p

18 watts of power at 240 v. straight to the bit

BIT SIZES:
19 (1·5 mm) 20 (3·0 mm)
21 (4·5 mm) 22 (6·0 mm)

Trade Enquiries Welcome

From your Local Dealer or Direct from the Manufacturers:

S. & R. BREWSTER Ltd.
86-88 UNION ST · PLYMOUTH Tel 0752·65011

GREAT AUTUMN SALE

High Ripple Current Electrolytics . . .
YOU CAN'T MISS THESE

Sprague Powerlytic (Screwed Conns) 33,000µF 40vdc	**£2.00** inc.
Sprague Powerlytic (Screwed Conns) 3,000µF 100vdc	**£1.20** inc.
Plessey Relialytic (Screwed Conns) 15,000µF 63vdc	**£1.80** inc.
Filmcap (Screwed Conns) 15,000µF 40vdc	**£1.50** inc.
Tag Electrolytics*	
4,700/40v **60p** 100/150v **40p**. 33/450v & 15/450v **40p**	
HIGH VOLTAGE POLYESTERS*	
0.1µF/1000vdc	5 for **£1.00**
0.047µF/1000vdc	5 for **60p**
0.1µF/600vdc	5 for **50p**
0.047/25v disc Ceramics	**£2.00** for 100
1µF/400vdc Polyester Blocks Radial Leads	10 for **60p**
Resistors:*	
10K 1/2 watt by ITT	200 for **£1.00**
390R 2½ watt	100 for **£1.00**
Tantalum Beads* 1µF/35v	10 for **75p**
1µF/50v	10 for **£1.00**
Semiconductors*	
10a/50v Bridges	**£1.50**
18a/50v Diodes Type 1N1191	5 for **£1.00**
Opto Isolators Type OPT601 6 pin D.I.L.	2 for **£1.50**
Meters*	
Sangamo Weston 60mm sq. 60-0-60mA	**£3.00**
Taylor ½ 5" x 3" 500µA calibrated in Degrees Tilt	**£3.50**
The following Items are not in the Sale	
Mk. 2. Metal Locator Kit	**£19.60** inc. VAT and P&P
Apollo Logic Tester	**£11.75** inc. VAT and P&P
S.R.B. Miniature Soldering Iron 16/18w	**£3.75** inc. V.A.T. P&P

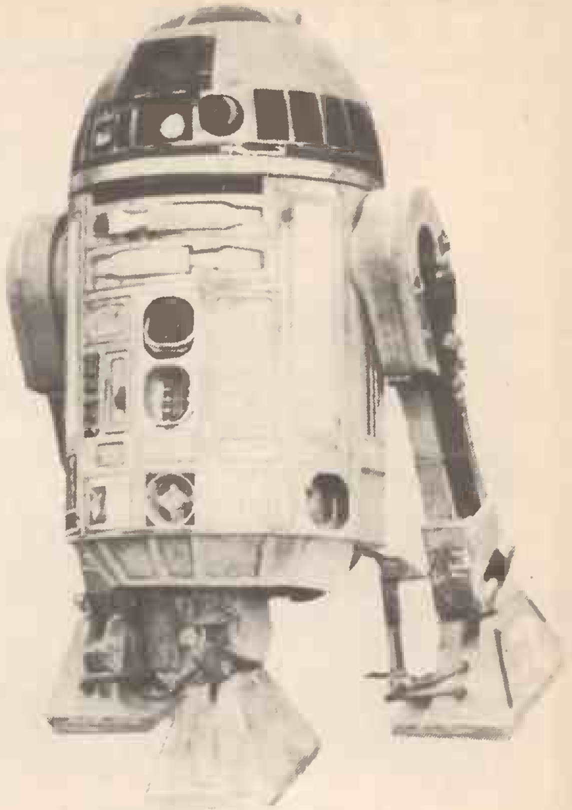
*Please include 35p P&P on orders for goods where P&P is not included. All prices include V.A.T.

R.F. EQUIPMENT SPARES LTD.

3 Lacy Close, Wimborne, Dorset BH21 1PY

Please note that our stores at Poole Road Works are open to personal shoppers on Friday afternoons and all day Saturday.

Robots



Are robots real? If not, why not — and when will they be? Jim Perry talks about the past, present and future of the world of R2-D2 and friends.

ROBOTS ARE ABOUT FORTY years old, in the latter half of the 30s a man called Rossum began manufacturing them. He had a small factory on the outskirts of Prague in Czechoslovakia. His robots, however, became illogical and revolted — burning the factory down to the ground.

In reality Rossum and his Universal Robots were the creation of Karel Capek, a Czech playwright, in 1923. He took the word 'robot' from the first part of the Czech word for worker — and the name has stuck ever since. Since then the science fiction writers have been light years ahead of the reality of robots. It is only in the last few years that the reality has started to catch up with the popular idea of a robot.

POPULAR ROBOTICS

After Kapek invented the concept of robots the science fiction writers had a field day. Asimov developed the famous three laws of robotics — partly from his own work and partly from other writers' concepts, and stated them in 1942

1 A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence, as long as such protection does not conflict with the First and Second Laws.

A production model of the Unimate industrial robot, manufactured by the Unimation Corporation. This one armed worker can memorize a sequence of steps and repeat them ad nauseum, however the unit is not mobile — the work is brought to it at a fixed position.

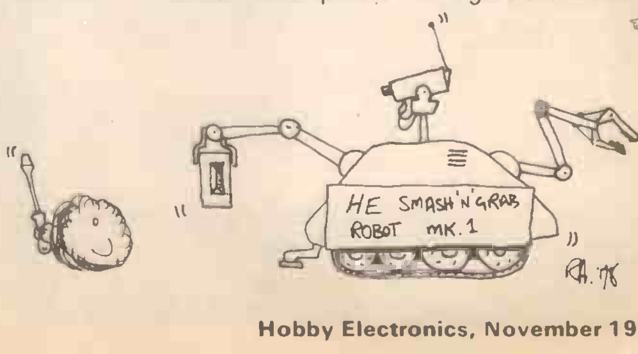
Asimov had put into words the basis for robot design — on the esoteric level. No robot designer can be expected to work from these three laws alone, in fact with the present level of robotics it is hard enough to make a robot look after itself!

The most popular medium for robots has been the movie film — with such famous robots as Tobor and Robby (from I Robot and Forbidden Planet respectively) fostering the robot myth. Of course the latest popular robots are K-9 and R2-D2, with R2-D2 being the most well known in the world. With the casing alone costing £3,000, R2-D2 was a very expensive robot model — with only limited motor functions and needing constant attention and mothering.

REAL ROBOTS

The first industrial robot in reality was the Unimate, a product developed at tremendous cost by Joseph Engelberge's Unimation Corporation. Founded in 1956 the company was to design and market a one armed robot, with a movement memory stored in solid state logic. Unimation invested about 12 million dollars and 16 years before they made any profit — robots are very capital intensive!

Research into robotics has increased a lot since the early 'Model T' days of the first Unimate, but as one eminent robitic researcher puts it "Imagine a blind man

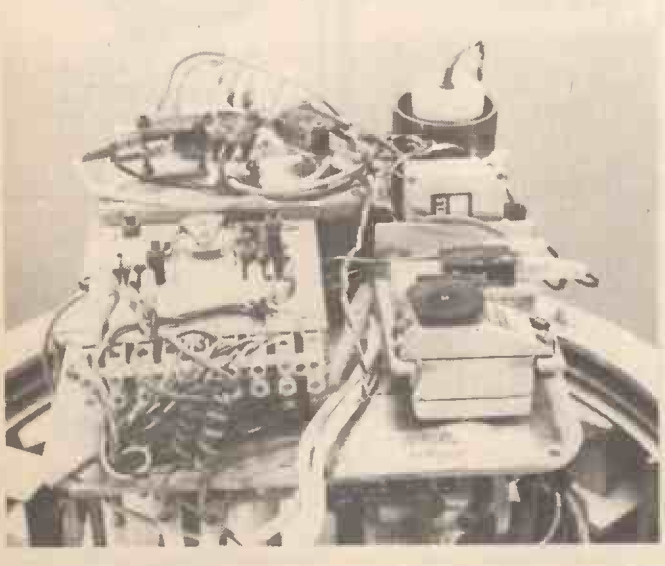


with one arm tied behind his back, the two fingers on his good hand numbed with novacaine. Furthermore, imagine that the man himself has less brain power than a trained monkey. That should give you a good picture of what today's industrial robots are like.'' That quote was from the leader of robotics research at Stanford University, Dr Tom Binford,.so much for R2-D2!

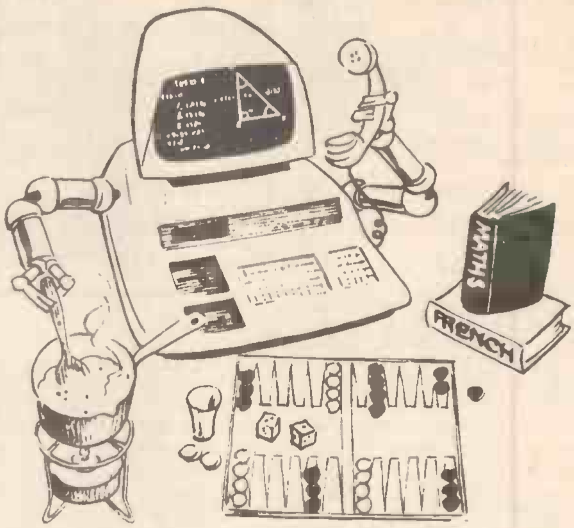
ROBOT DESIGN

There are two basic areas where robotic research is behind the dreams of sci-fi writers, namely the mechanics and the control system. Work is taking place in both areas, but they are in the equivalent of the stone age compared to what they could be.

This closeup of a Star Wars robot gives an idea of the probable visual aids robots will use. Even though the twin TV cameras in this robot were dummies, real robots will have to use some form of image recognition. The main holdup is in the computer techniques needed to intepret the signals from the 'eyes' of the machine.



Inside the real R2D2, modern technology for robots relies heavily on sophisticated mechanics. The future will bring ultra miniaturisation of the present bulky parts — and enable far more to be crammed inside the robot shell.



Humans have at least five senses, to help them along in the world, robots are lucky if they have two (touch and sight). The sensors for sight, touch and hearing are available, but they are crude compared to their human equivalents — and as yet no robot can smell or taste anything. Potentially the robot can have the edge over a human, with facilities such as X-ray vision and ultrasonic hearing.

As well as sensors the robot needs flexible actuators (hands, legs, fingers) in order to be of much use to anyone. Research into both sensors and actuators is taking place in several parts of the world, and both are becoming increasingly sophisticated.

Control systems for robots is an area that is experiencing the most intensive research. The human has the benefit of 'wet logic technology' or a brain if you prefer, robots have to make do with computer control. The software needed to cope with the real world is rather different than that needed for a game or payroll program. Artificial intelligence is the name of the game and thousands of human man years together with millions of computer hours are being devoted to the subject.

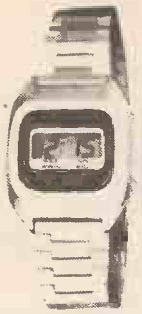
THE FUTURE

The ideal robot will need sensors to interpret the environment around it, a computerised control system to decide what to do with the sensor information (and remember any set tasks), and last but by no means least — actuators (arms, legs etc) to accomplish the task.

The technology is not available to provide all three parts in a single mobile robot, yet. With another 20 to 30 years we can expect to see the first attempts at mobile, self contained, useful and semi-intelligent robots. At the moment the one armed idiot robots are used for tasks such as spotwelding on production lines, the future generation may well see the robot butler — unfortunately the first true robots will probably be used by the military — they are the only organisations that will be able to afford them! **HE**

SAME AS ETI OFFER

5 FUNCTION LCD



Hours, mins, secs, month, date, auto calendar, back-light, quality metal bracelet.

£8.65

SPECIAL TO ETI READERS

Solar + alarm LCD watch

SOLAR ALARM WATCH

- Hours, mins, secs displayed.
- Day, date, day of week.
- 24 hour penetrating alarm.
- Quality metal bracelet.
- Powered from solar panel. With battery back-up.
- Back-light + auto calendar.

£29.95

"QUARTZ LCD ALARM"

Snooze + backlight. Batteries last 1 year approx. Includes batteries and travel pouch. Excellent value

£17.65

THOUSANDS SOLD 11 FUNCTION SLIM CHRONO

6 digit 11 functions

- Hours, mins, secs.
- Day, date, day of week.
- 1/100, 1/10, secs, 10 x secs, mins.
- Split and lap modes.
- Back light, auto calendar.
- Only 8 mm thick.

This same watch is being sold for £22.00 in newspaper and magazine special offer ads.

Metac Price £12.65

SEIKO

The Seiko Quartz Collection encompasses a wide and exciting range of quartz watches for men and women. Day/Date quartz. Ultra-thin quartz. Digital quartz watches with liquid crystal display for continuous readout. Even a digital quartz alarm chronograph. It's what you'd expect of Seiko. The first quartz watch ever sold was a Seiko. And Seiko's expertise in every phase of the watchmaking process makes it possible for Seiko to make any part of any Seiko watch, and to exercise a unique quality control system through every step from design to completion. Whichever Seiko Quartz model you select, you get more than just a technologically advanced timepiece.

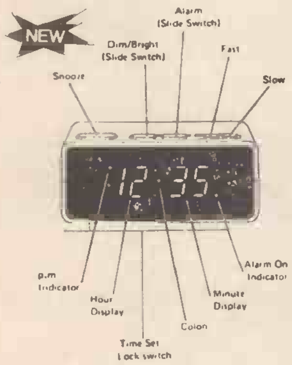
ALARM CHRONO
List Price £130
Metac Price £105

CHRONO
List Price £85
Metac Price £68

MULTI-ALARM
List Price £120
Metac Price £98

CALC-WATCH
List Price £165
Metac Price £125

HANIMEX Electronic LED Alarm Clock



Feature and Specification

- Hour, minute display
- Large LED display with p.m and alarm on indicator
- 24 Hours alarm with on-off control
- Display flashing for power loss indication
- Repeatable 9 minute snooze
- Display bright/dim modes control

Size 5.15 x 3.93 x 2.36 (131mm x 100mm x 60mm)
Weight 1.43 lbs (0.65 kg)

£8.65

SOLAR

5 function LCD

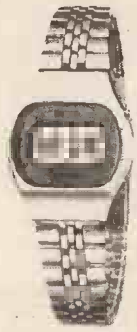
- Solar panel with battery back-up.
- Back light + auto calendar.
- Hours, mins, secs, day, date.
- Quality metal bracelet.

£12.95

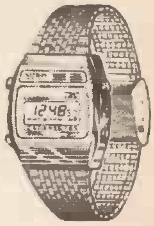
LADIES LCD

Only 25 x 20 mm and 6 mm thick. 5 function: hours, mins, secs, day, date. + back light and auto cal. Elegant metal bracelet in silver or gold. State preference.

£10.95



ALARM LCD



6 digit 7 function hours, mins, secs, day, date, day of week. 24 hour penetrating alarm. Back light + auto calendar

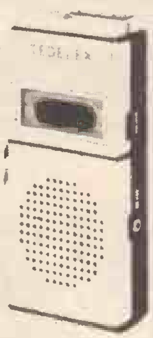
Only £24.95

THE METAC DIGITAL CLOCKS ★ COMPLETE KIT ★

- Pleasant green display - 12/24 Hour readout
- Silent Synchronous Accuracy - Fully electronic
- Pulsating colon - Push-button setting
- Building time 1 Hr - Attractive acrylic case
- Easy-to-follow instructions - Size 10.5 x 5.7 x 8 cm
- Ready drilled PCB to accept components

PRICE £6.65

MICRO CASSETTE RECORDER



Hand-held only 2½ x 5 x 1½ inch. Identical to well known models being sold at £35

OUR PRICE £24

SINCLAIR SCIENTIFIC PROGRAMMABLE

+ free program library worth £4.00

ONLY £12.65 FROM METAC

All products carry full 12-month guarantee. Please add 30p P&P with all orders. All prices include VAT.

Shops open 9.30 to 6.00 daily.

Trade enquiries welcome.

COMPONENTS

2N3055 transistors 50p
.2 inch LED's, red 12p
green 15p
yellow 15p
orange 15p
DL 704 displays 80p
DL 707 displays 80p
Watch batteries 70p
(state type)
Mercury tilt switches 50p
Crystal mic. inserts 50p

Also useful for sonic applications and sound transmitters (buzzers etc)

METAC EXCLUSIVE CALCULATOR WATCH + STOP-WATCH SEIKO STYLE

Calculator: X, ÷, +, −, K
Time: hours, mins, secs, day, date, day of week

PRICE £49

TV GAMES

Black & white £9.95 Colour £12.95
4 games, 2 ball speeds, 2 ball angles, 2 bat sizes.

Access
Buy it with Access

METAC Electronics & Time Centre

67 HIGH STREET
DAVENTRY, NORTHANTS
Tel. (032 72) 76545

327 EDGWARE ROAD
LONDON W2
Tel. (01) 723 4753

Barclay & Access welcome
Phone or Send Card Number with order

BARCLAYCARD

Waa~waa Pedal

Many electronics enthusiasts, although not musicians themselves, find that the cheapest way to pursue their Hobby is to build musical devices of one sort or another for other people to use—at a price!

WHAT, the uninitiated will ask, is a waa-waa ? The simple answer is that it's something which, when trod on, goes "Waa-waa".

To those slightly more au fait with the state of the art in the rock world, the waa-waa is a foot-controlled swept notch filter for use with instruments with a high harmonic content output.

Basically, it's an effects unit — it goes between an electric guitar and it's amplifier. By operating the foot pedal, the guitarist can (especially if 'picking') produce the characteristic effect which gives the device its name.

As well as the inevitable input and output sockets and on/off switch, this pedal also has a push-button 'bypass' switch (set in the 'heel' of the pedal) which, when operated, removes the effect altogether until it is pressed again.

CONSTRUCTION

The pedal we have specified requires some holes drilled for the switches and sockets, but anyone with access to a hand drill should be able to manage this.

Another small problem is that the pedal mechanism comes complete with a potentiometer already fitted — but it's not the right type for this project. Changing it for the right one is a simple enough matter — taking a look at the mechanism should be enough to allow you to see how it's done. The only problem is in making sure the potentiometer is in the right position when the pedal is put back together. In other words, to make sure that the spindle is turned anti-clockwise when the pedal is fitted back onto the rest of the mechanism in the 'foot off' position.

Again, a little thought and a quick fiddle will sort this out (Yes, it will work with an electric fiddle as well as an electric guitar!).

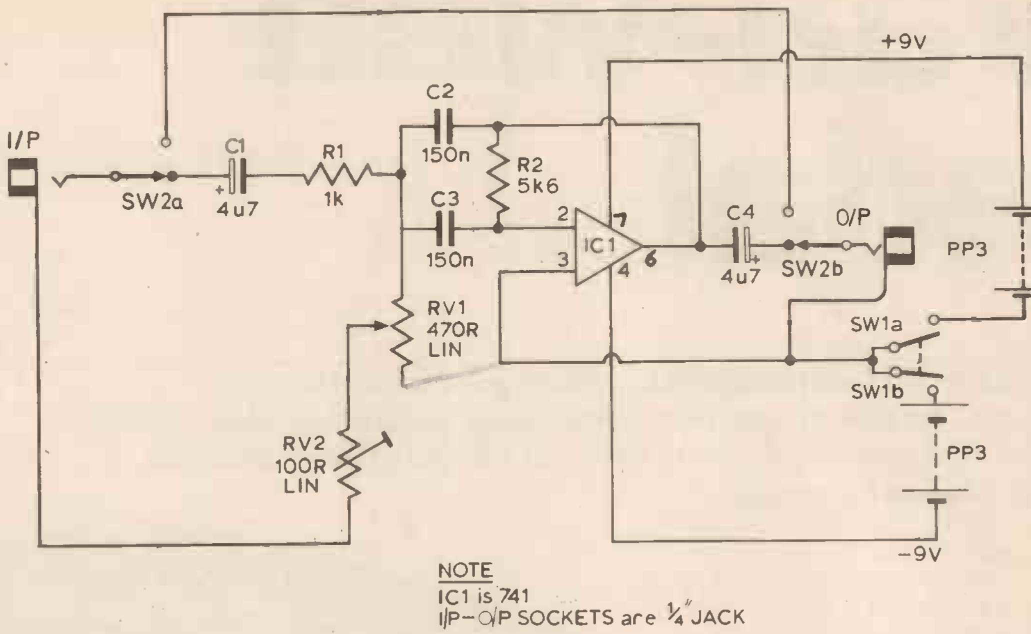
Lastly, the pedal is really meant to be screwed down onto something. We suggest a small piece of ½in chipboard — this gives it stability and stops it scratching hardwood stages!

BOARD

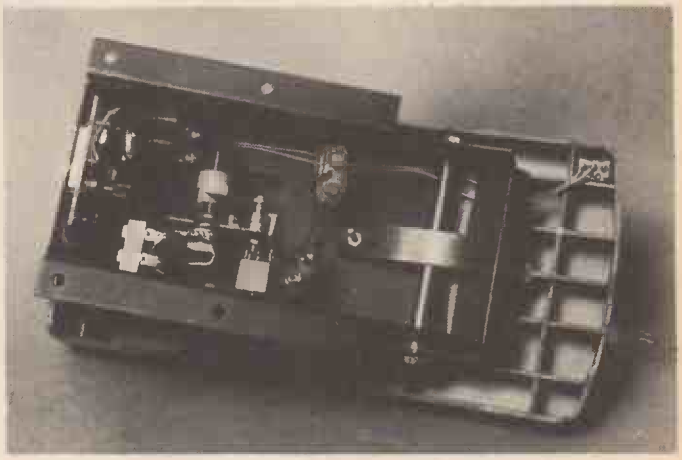
Putting the electronics together is probably the easiest part of all — make sure you get capacitors 1 and 4 the right way round, though — look at the diagrams closely before assembling. Electrolytic capacitors should have an indented ring around the +ve end.

The integrated circuit goes in with the dent in one end of it aligned as shown. We suggest that you use an integrated circuit socket (IC socket) — this is soldered into the board and the IC plugs into it — saves endangering the IC by heating it. If you do use one, make sure all the IC pins go into the holes and that none are bent under the body of the IC.

You may notice that the IC pin numbers shown on the circuit diagram start on the actual IC body with pin 1 where the dot on the body is and go anti-clockwise.

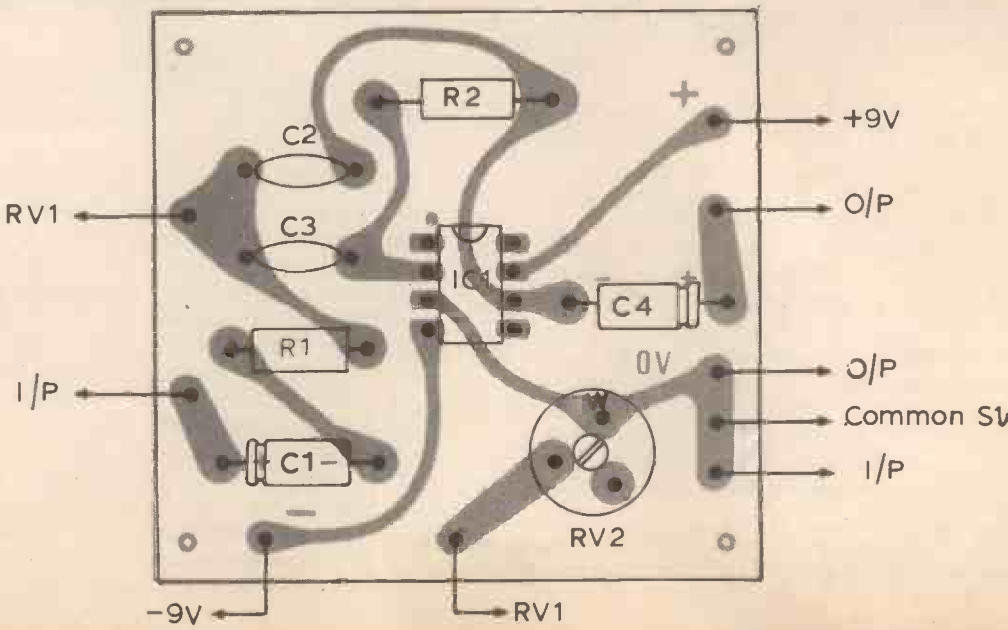


The circuit diagram. To find out how it works, read the 'How it Works' section!



An internal view. The eagle-eyed amongst you may notice that there are only two wires connecting the bypass switch to the circuit. This is because in the prototype we opted for a simpler (although less electronically aesthetic) means of bypassing the circuit — connecting the output directly to the input while leaving the circuit connected to both!

The overlay — where to put the bits on the board.



How it Works

The input to the device is through C1 — this removes any DC bias from the signal. C4 acts in a similar way on the output signal. This process is called 'de-coupling'.

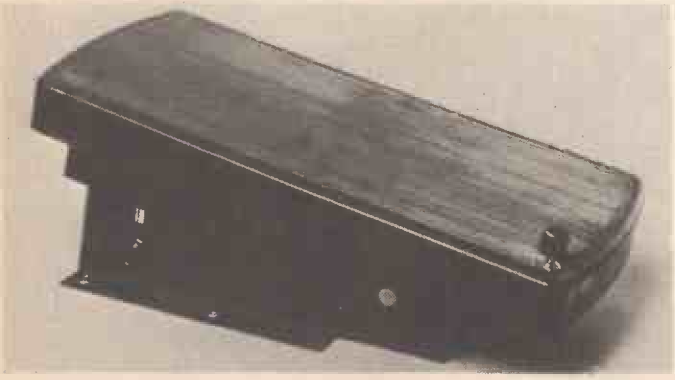
IC1 is an operational amplifier — a rather single-minded device whose only aim is to fiddle the voltage at pin 6 (the output) to try to keep the voltage at pin 2 (the inverting input) the same as at pin 3 (the non-inverting input). In this case, the voltage at pin 3 happends to be zero. Anyway, we're allowing the deive to do this to an extent, but we're crippling it by means of C2, C3, R2, RV1 and RV2 in such a way that:

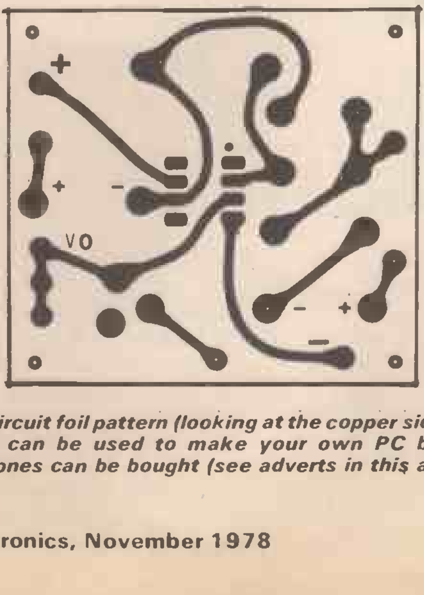
a) the output follows the input through R1 to an extent — it has to do this to try and keep the voltage at pin 2 constant.

b) it can control the voltage at pin 2 at all but one frequency (this frequency is 'blocked' by C2, C3 and R2) and thus that frequency 'appears' at pin 6 as it tries frantically to control the voltage at pin 2.

c) that frequency is dependent on the resistance of RV1 and RV2.

So, all in all, the output of the circuit will be that fraction of the input which falls at and near the frequency RV1 is set to. By changing the setting of RV1, you 'sweep' this frequency up and down the audio band, producing the required 'waa-waa' sound.





The printed circuit foil pattern (looking at the copper side of the board). This can be used to make your own PC board or ready-made ones can be bought (see adverts in this and later issues).

WIRING

If in doubt about where to connect the wires to or from, follow the circuit diagram — remember it's just the same as the real thing.

When fitting RV2, notice that the letter W on the overlay (which tells you what bits go where on the board) refers to the 'wiper' contact of RV2. This is the contact which slides along the resistive 'track'.

RV1 should be wired with one connection to both the middle (wiper) contact and one of the end contacts, and one connection to the other contact.

Two-position switches (also called 'double-throw' switches) have a similar arrangement to potentiometers — the middle contact is the one that 'moves'

SETTING UP

The preset control, RV2, should be adjusted before you screw the pedal down — just attach a guitar and an amplifier and tweak it till it sounds right! This is probably the best way to do it — especially if it's you who will be using it. If it's built for someone else, then get them to tweak it!

All in all, this is a simple project on the electronic side, with a small amount of metalwork to be done to produce a really professional finish.

HE

Parts List

RESISTORS		
R1	1k0	
R2	5k6	
CAPACITORS		
C1,4	4u7	20V electrolytic
C2,3	150n	polyester
SEMICONDUCTORS		
IC1	741	operational amplifier
POTENTIOMETERS		
RV1	470R	linear
RV2	100R	preset linear

MISCELLANEOUS

PCB as pattern; 2 off PP3 9V batteries; 1 miniature toggle double-pole, double-throw switch; 1 miniature push button locking double-pole, double-throw switch, 2 off ¼in jack sockets, battery clips to fit.

The foot pedal mechanism we used came from MAPLIN Electronics, PO Box 3, Rayleigh, Essex, SS6 8LR (order as 'swell pedal').

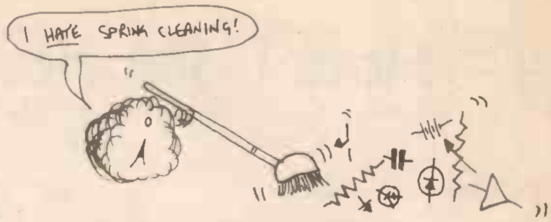
The push-button two-position switch was from RS Electronic Supplies, PO Box 427, 13-17 Epworth Street, London EC2P 2HA (01-253 3040). Order as "339-235".

We suggest you 'phone or write to find out the prices of the above.

All the rest of the components should be available either through advertisers in this magazine or from electronic component shops.

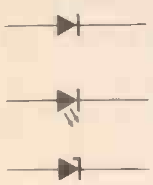
Approximate cost: £15

Circuit Symbols



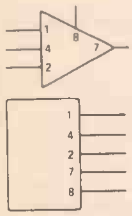
We have tried to cover here all of the symbols used in this issue.

ACTIVE COMPONENTS

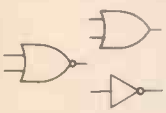


Three types of diode. The first is just a diode, the second is a light emitting diode (which glows when current passes through it). The third is a zener diode, used for creating fixed voltages.

Two types of transistor. The first is NPN, the second PNP.



Integrated circuits. The box can be of almost any shape, although the top one is usually used to indicate some form of amplifier. The numbers refer to the pin numbers on the IC package.



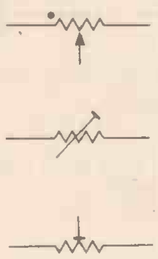
Logic gates. Logic ICs usually contain several of these each, and so they are suffixed IC1a, IC14b, et cetera.

RESISTORS AND CAPACITORS

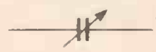
A resistor.

Two types of capacitor. The lower one is of the "electrolytic" or "tantalum" type and can only be used one way round.

A coil. The lines indicate what it was wound on. Two coils which share the same lines represent a transformer.



Various forms of variable resistor. The top one is panel mounting, the dot representing the right-hand side when viewed from the front. The other two are pre-set resistors which are used for setting up only. The middle one has its sliding contact connected to one end of the resistive "track."

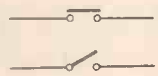


A variable capacitor.

MISCELLANEOUS

Two wires crossing on a diagram without touching.

Earth symbol. Usually means battery negative terminal or chassis.



Two different types of switch. The upper one is only closed while it is held closed.

A loudspeaker.

A fuse.

A battery. The short terminal is negative (easy to remember it looks like a "—").

A "jack" socket and a "phono" socket.

PROBLEMS

Suffixes 'k', 'm', 'M' etc after component values indicate a numerical multiplier or divider — thus

Multipliers

k = X 1000
M = X 1000 000
G = X 1000 000 000

Dividers

u = ÷ 1000 000
n = ÷ 1000 000 000
p = ÷ 1000 000 000 000

Where the numerical value includes a decimal point the traditional way of showing it was, for example, 4.7k. Experience showed that printing errors occurred due to accidental marks being mistaken for decimal points. The Standard now calls for the ex-suffix to be used in place of the decimal point. Thus a 4.7 k resistor is now shown as 4k7. A 2.2 uF capacitor is now shown as 2u2 etc.

Some confusion still exists with capacitor markings. Capacitors used to be marked with multiples or sub-multiples of microfarads — thus 0.001 uF, 470 uF etc. Markings are now generally in sub-multiples of a Farad. Thus —

1 microfarad (1u) = 1×10^{-6} F
1 nanofarad (1n) = 1×10^{-9} F
1 picofarad (1p) = 1×10^{-12} F

OV on our circuits means the same as —ve (an abbreviation for 'negative'.

Unless otherwise specified all components in our drawings are shown as seen from above — note however that component manufacturers often show them as seen looking *into* the pins.

Pin numbering of ICs — with the IC held so that the pins are facing away from you and with the small cut-out downwards pins are numbered anti-clockwise starting with pin number 1 at bottom right.

The thin line on a battery schematic drawing is positive (+ve or just +).

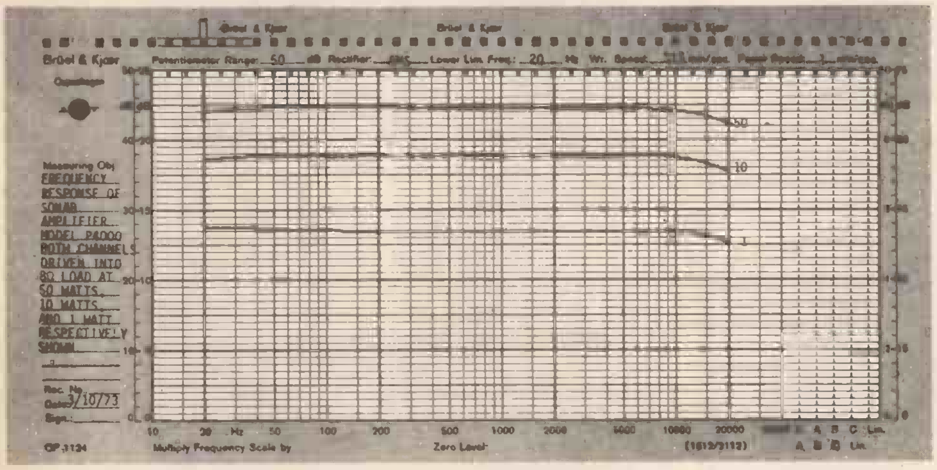
If a circuit won't work the most probable causes of trouble in the most probable order of occurrence are: —

(a) Components inserted the wrong way round or in the wrong places.
(b) Faulty soldering.
(c) Bridges of solder between tracks (particularly with Veroboard) — breaks in Veroboard omitted — and/or whiskers of material bridging across Veroboard breaks.
(d) Faulty components.

Hi-Fidelity Specifications

—Amplifiers

Amplifier manufacturers strive for clarity of sound — but few of them [illegible] for clarity when it comes to specifications. Ron Harris attempts to clear up some of the confusion surrounding the numbers game.



Typical frequency response presented as a graph of level against frequency. As you can see, this model of amplifier begins to 'fall away' high in the spectrum. A good result would be 'ruler straight' between 40 Hz and 20 kHz.

IN AN IDEAL WORLD all hi-fi equipment would sound the same. Perfect. As it is we are stuck with less than perfection — all the women don't look like Felicity Kendal and beer *isn't* 2p a pint — and so perhaps imperfect hi-fi is one of the more bearable evils.

The task of an amplifier in a system is to take the tiny voltages produced by pickups, tuners and the like and convert them to a suitable level to drive a pair of loudspeakers. Along the way it should provide any tone control and filtering required and have outputs to enable recordings to be made from whatever source is being used.

A simple enough job — if you say it quickly enough — but it is the different attempts made at it by all the commercial units around that have produced all the lovely confusion we now have.

ONE BIT OR TWO?

A complete amplification system for hi-fi consists of a pre-amp, or control unit, a power amplifier and a power supply. The pre-amp performs all the initial increases in the signals, bringing them all to the same level of about a volt, and provides the tone controls, filters, input selection and volume control facilities.

The power amplifier's function to turn that one volt into quite a few more to run the loudspeakers. And that's all. In doing so it should introduce as little of its own accompaniment to the music as possible.

The power supply is to reduce the mains to a suitable value to power all the other circuitry, providing both a stable and exact voltage for the pre-amp, and a larger, heavier current supply for the power amplifiers.

Once upon a time when amplifiers contained lots of nasty glass 'things' called valves and got hot enough to cook toast over, it used to be that the best quality sound was to be obtained from having the control unit and power amp separate — witness the hallowed Quad 22. To some extent the trend continue in the very top ranges of hi-fi, but integrated units — that is those with everything in one box — can now offer comparable performance and should not be shunned simply on account of only having one case to their name.

GETTING IT IN — AND OUT

Connections to an amplifier are always made using screened (against the outside world) cable for the low level inputs, heavy cable for loudspeakers and some form of plug and socket to enable all the other units to be hooked into the magic box with gain. The most common sort are the phono plugs. These use a separate connector for each channel, and are much sturdier than their main rival — the European DIN plug. The DIN plug — usually five pins, sometimes more, carries all things within a single plug and is thus neater. It is also murder to work with.

My personal idea of Hell is to be stuck in a huge room full of seven pin DIN plugs, an endless reel of tiny screened cable and solder — and a huge evil demon with two foot talons ensuring the soldering iron never rests!

If you *have* to use DIN make it easy and buy the leads from the shops.

THE POWER OF RATINGS

Specifying just how powerful a particular amplifier is can be confusing and sufficiently open to interpretation to allow manufacturers to shed a better light on their products. There are many ways to spout figures (all different) for the same device. Speaking as an engineer, the number to be most trusted is the one followed by "RMS".

Stereo pre-main amplifier. Inputs: mag PU (1) 1mV 100K, PU (2) 1-4mV 30-100K, radio 200mV 45K, aux 200mV 45K, tape 200mV 45K, tape (DIN) 330mV 100K. Output: 60W RMS per channel, both channels driven into 8 ohms. THD: less than 1%. Controls: loudness +10dB at 50Hz and +6dB at 10kHz, low filter −10dB at 50Hz, bass ±10dB at 50Hz, treble ±10dB at 10kHz. Load impedance: 4 to 16 ohms. Power bandwidth: 5Hz-50kHz. S/N ratio: phono 70dB, tape 80dB. Phono overload: 130mV. Mains: 100, 117, 220, 240V AC 50/60Hz. Size: 16½ × 5½ × 12in. Weight: 30lb.

Note that this fairly average specified power output is given for "both channels driven". This is quoted because, with only a single power supply to drive the two channels, less power is available if both are driven at the same time and so the single channel rating would be higher.

This is a measure of how much power can be *continually* drawn from the amplifier, and is usually obtained by using sinewaves as an input, and a resistor to replace the loudspeaker. RMS stands for root mean square, a term used when dealing with AC (alternating current) such as the mains: this in turn can be related to the peak, or highest value of, power by the number 1.414 ($\sqrt{2}$).

It is this 1.414 link which allows for the first deception. A 50W RMS output becomes nearly 75W peak when so multiplied — looks more for your money doesn't it? Peaks don't last long though.

Another method of saying what's watt is the IHF standard or music power rating. This again relates to the ability of an amp to supply voltages in short bursts rather than on a continuous basis, and so will be again higher than RMS. As music is composed of short 'bursts' there is some relevance to these ratings, but if only these are quoted then beware — why not RMS as well?

HOW MUCH IS TOO MUCH?

The question of just how many watts you need depends on how big a room you're pumping the sound into. Allow 25W RMS for the first 1000 cu ft and 10W per 1000 thereafter — assuming you're using speakers with average efficiency. It is good to have power in reserve rather than flogging the circuits to death, but take care with the volume control if your amp is *too* powerful. One mistake and it's back to the bank for an overdraft to finance new speakers.

SOUND HERTZ

Frequency is measured in cycles per second — Hertz — and the range of sound we can hear runs up to 20000 Hz (20kHz) for young kiddies and liars, and around 16-18 kHz for humans in their twenties. By the time your forty and on the Phylosan, anything above 14kHz is not for you.

At the lower end the living room limits the sound to no lower than 40Hz unless huge (more than 30 cu ft). This is because the wavelength of the reproduced sound has to be smaller than the room you're trying to produce it in, and around 40Hz it gets bigger.

This means the range we're interested in is 40Hz — 20kHz at most, and the amplifier should deal with all frequencies within this range as equally as possible. Frequency response is the way this equality is measured. The units employed are decibels (dB) which are logrithmic in nature, and used to compare something against a reference.

For frequency response purposes the reference is usually the amplifier's performance at 1kHz, and deviation either side of this level is given in dB. e.g. 40Hz to 20kHz ± 3dB means that all frequencies within this range are handled at a level not more than 3dB away from the reference point. How 'smooth' is important, but even the best ears in the audio world would need a good clean out to detect an overall deviation of 2dB.

WIDE BOYS

In this case too wide a response is not a Good Thing. Running a power amp's response flat up into the 100kHz range only leaves the window open wider for more muck to fly in. 30kHz is adequate for music reproduction given good design, and so regard anything more as a potential Bad Thing until the sound proves you wrong.

Too low can likewise cause problems. Record warps and turntable rubbish exits in a band from 5Hz to 10Hz, and amps should be blind to such things. The best way to meet these requirements is to design flat, and 'roll off' the response below 20Hz and above 30kHz.

Another useful measure is called power bandwidth, and is given as the range of frequencies over which the amplifier can deliver at least half its rated power output. Half power is —3dB and so a decent spec. might be power bandwidth: 20Hz — 30kHz (—3dB.)

DISTORTING THE TRUTH

One famous manufacturer described the perfect amp as a piece of wire with gain. In other words it adds or subtracts nothing from the signal — just makes it larger. As we have already bemoaned, however, no such animal can be bred. All amplifiers distort the signal and all add noise to it.

Distortion can be generally classified into three types. Harmonic, transient, and intermodulation. All musical instruments generate harmonics, so it should not come as a complete surprise to find amplifiers do as well. If a pure tone (sinewave) is fed into an amplifier it will produce other frequencies as well, in varying amounts. Even harmonics are less objectionable subjectively than odd harmonices — but unfortunately, or inevitably, transistor amplifiers produce more odd harmonics than anything else. Valve amps — heat and all — generate mainly second harmonic distortion, and are preferred by some for this trait.

Transients are sudden changes in level of a signal, which therefore call for the amplifier to switch level rapidly also. If it is not well controlled this sudden plunging change can cause instantaneous overload in the output stage and consequent distortion. Too wide a frequency response can complicate things here too. Such an unfortunate occurance is termed Transient Intermodulation Distortion and was a free bonus with some early Japanese designs. Happily, recent ranges have dealt with this problem with the usual (infuriating) Oriental efficiency.

Since a music signal consists in essence of several sounds going on at once, any unwanted interaction generated by the amplifier itself is to be condemned. Non-harmonic frequencies are generated in such circuits, by addition of two wanted frequencies to produce a third unwanted signal, i.e. 7kHz and 100Hz might produce 7 100Hz and/or 6 900Hz in an offending circuit. This is termed intermodulation distortion (IMD).

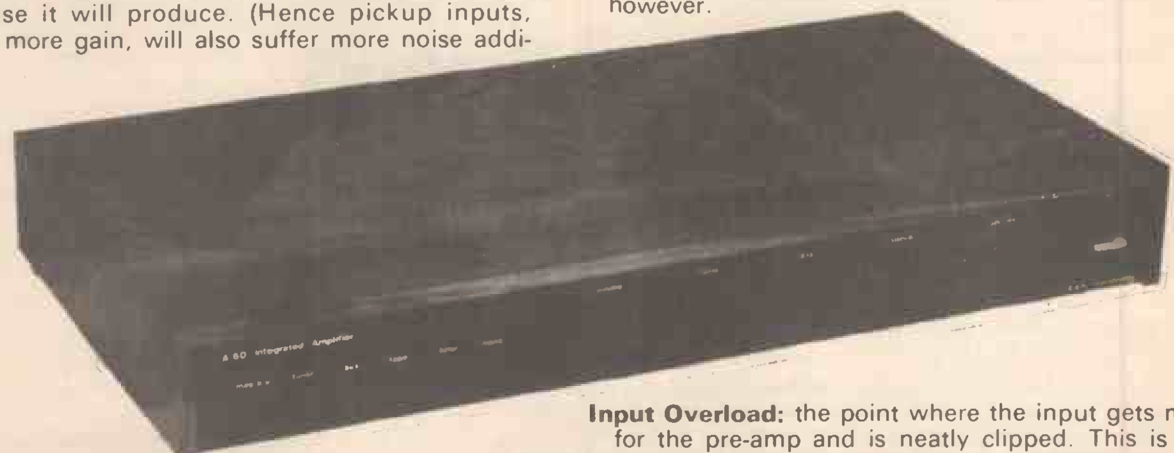
Levels of less than 0.1% of IMD count as hi-fi. Higher levels can be treated with disdain!

CROSSING OVER AND BEING DYNAMIC

One last word on distortion. Crossover distortion is a parameter of a type of output circuit known as class B (and AB) and was prevalent in the early days of transistor amps. It manifests itself as a roughness in the sound at low levels. Modern amps have managed to rise above this evil to a large extent — but keep an ear out all the same.

Besides distortion noise is added to a signal by every electronic circuit, and the art of design is to make as little of it as possible while making as much music as possible.

The more amplification we ask for from a circuit the more noise it will produce. (Hence pickup inputs, requiring more gain, will also suffer more noise addition.)



Weighted noise figures are to take account of the fact that the ears are more sensitive to some frequencies than others, and so some will be more annoying than others. There are two main weightings you are liable to come across DIN A and DIN B. The 'A' rating is slowly being replaced by CCIR which gives a better correlation between noise and annoyance. Treat them as more meaningful figures.

Noise is normally included in specifications as a ratio against signal (S/N ratio) and is quoted in dB. Better than 60dB is good for pickup inputs, and 80dB is good anywhere else! The difference between the value of the noise signal generated by the amp and the loudest note it can produce cleanly (without distortion) is known as its dynamic range, and the term is sometimes used to replace signal-to-noise ratio.

HUM, WHAT NEXT?

The mains supply used to power domestic equipment has a frequency of 50Hz, which lies just inside the audio band. If wires carrying this 240V signal are too close to cables conducting the 100mV or so music signal, 'breakthrough' can occur, and the 50Hz becomes superimposed on the music as 'hum'. Usually the amount of this is included with noise to give an overall signal-to-noise, including hum.

There are a few other terms which are liable to crop up, and perhaps the best way of dealing with these is by:—

Damping Factor: a measure of the amount of control an amplifier has over the loudspeaker. It is measured as the ratio of amplifier output impedance to loudspeaker impedance. i.e. if output impedance is 0.5 ohms (typical value) and 8 ohm speakers are in use, then damping factor would be 40. Any value over 25 is more than good enough.

Crosstalk: how much the two channels within the amplifier interfere with each other. Quoted as a ratio of wanted signal to interference (dB). Any value higher than about 40dB should cause no problems.

Clipping: the point where an amplifier reaches its limit of operation, and refuses to amplify a signal any further — it clips off the top of the waveform instead. Used generally to show the maximum power possible before gross distortion occurs.

Input Sensitivity: a signal level which will produce full rated output from the amplifier if applied to an imput. Levels of senstivity vary from input to input, but in general pickup circuits should operate with between 2mV and 3.5mV as an input, and aux, tuner and tape with about 100mV. Exact levels are not important however.

Input Overload: the point where the input gets much for the pre-amp and is neatly clipped. This is very important with respect to pickup cartridges, as these can produce quite large signals, up to around 100mV, if the record is particularly loud. To be safe the phono input should have an overload point of not lower than 100mV. Others are supposed to be O.K. up to a couple of volts.

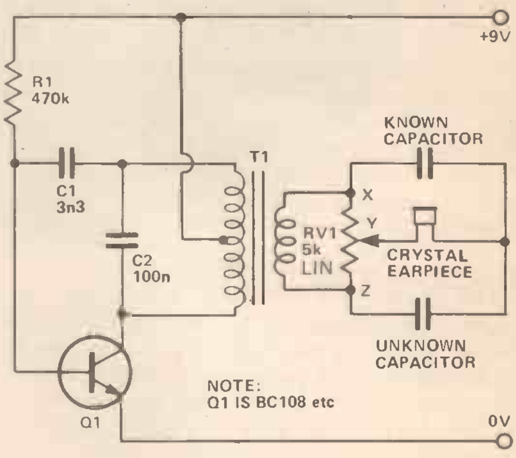
EAR EAR

Finally the most important spec of all — how it sounds. All the circuit tricks in the world are of no avail if the result sounds like a cat's choir on Wigan Pier. After reading through the numbers, and comparing the price tags point the finger at the potential purchase, and turn on the lugholes. If you don't like the sound — forget it no matter how impressive it looks on paper. Back to the drawing board. HE

Short Circuit

MEASURING UNKNOWN CAPACITORS

Although using only a handful of components with four reference capacitors, the circuit on the right will allow the values of practically all capacitors to be measured with a fair degree of accuracy.



This simple circuit will enable you to find out the value of an unknown capacitor, it makes use of the 'Bridge' principle. The interesting part of the operation is to the right of T1, the rest of the circuit, including Q1 is simply an audio oscillator. T1 is a small transistor output transformer as found in nearly all transistor radios, a commercial version is widely available from component shops (LT700). Connected as shown, the circuit is known as a Hartley oscillator C2 converts the primary of the transformer into a tuned circuit operating in the audio range whilst C1 feeds back part of the signal to keep oscillation going. The effect of all this is to generate an audio signal into the secondary of T1

Let us take a case where the two capacitors are the same value and the resistance in RV1 between x-y and y-z is the same; in that case the voltage at y and at the junction of the two capacitors will be the same and nothing will be heard in the earpiece.

Assume now that our unknown capacitor is half that of our known. A larger amount of the signal will pass through our known component, the bridge is upset and a signal will be heard in ourearpiece. However, if x-y is twice y-z, balance will once again be achieved and nothing will be heard. It follows that if a pointer knob of RV1 is marked in ratios, we will be able to calculate the value of almost any capacitor as long as we use as our reference component one that is between ten times and one-tenth of the unknown; this is because it is only practical to mark out ratios of 10:1. This is not as much of a problem as may first be imagined as values between 1p and 100uF can be checked using four standards — these are 10p, 1n (1000pF), 100n (0.1uF) and 10uF. However, measuring low capacitance is likely to be inaccurate due to strays in the circuit and note that electrolytic capacitors are not normally close tolerance components.

Bedside Radio

You can buy cheap transistor radios easily — but how about building a cheap transistor radio? Try our Bedside Radio and tune in to the wonderful world of Hobby Electronics!

Useful things filing boxes! As you can see we built the Bedside Radio into a plastic filing box, available from most good stationers.

IN THE EARLY days of both disciplines, electronics and radio communications were synonymous and since then radios have held a special place in the heart of many an electronics engineer. The thrill of fitting that last component, turning on and tuning in to some exotic, foreign sounding station (Radio 1?) for the first time, is not easily equalled.

BESIDE THE BEDSIDE

Before going any further though, let's just say that if all you want is a radio pure and simple, you would be better off going to your local supermarket and buying a ready-built set. This will be cheaper, quicker and, while our radio gives a very good sound, your market specials will probably be better. The fun is somehow lacking if you get your radio this way however and you cannot get the same feeling of pride when some obscure object from the East bursts into song.

The Bedside Radio is very simple in appearance, the front panel featuring the bare minimum of a volume control and tuning knob. The view of the inside of the radio shows that construction is quite straightforward with most of the components being mounted on a single printed circuit board (PCB).

CONSTRUCTION

We suggest that the PCB shown is used to build the radio. It should be available through advertisers in this issue. Having sorted that out and bought all the components, the first step is to mount the components onto the board according to the overlay. With this done the next thing to tackle is the winding of the coil. This is home-made and is formed by closely winding 80 turns of 32 SWG wire on a ferrite rod ⅜'' in diameter by 5¼'' long. You'll find it will help if the coil is wound over a piece of paper that has been first placed round the rod. When the last turn has been wound, secure the windings with a piece of sellotape.

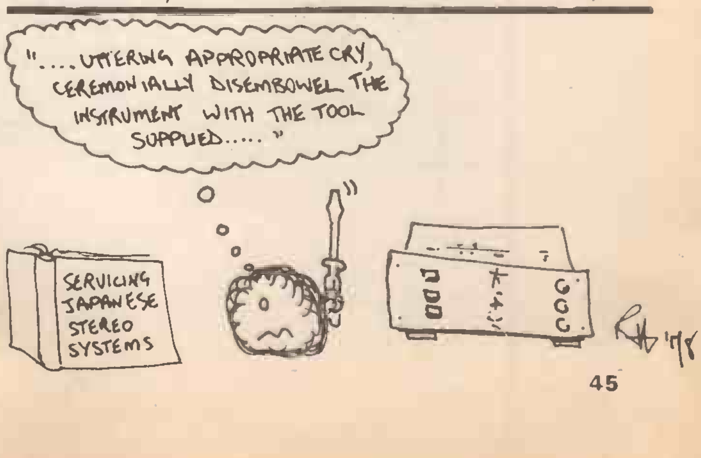
Drill and label the front panel next after which the various sections of the radio can be mounted in the case. The box we used was a file case and provided a very neat home for the radio.

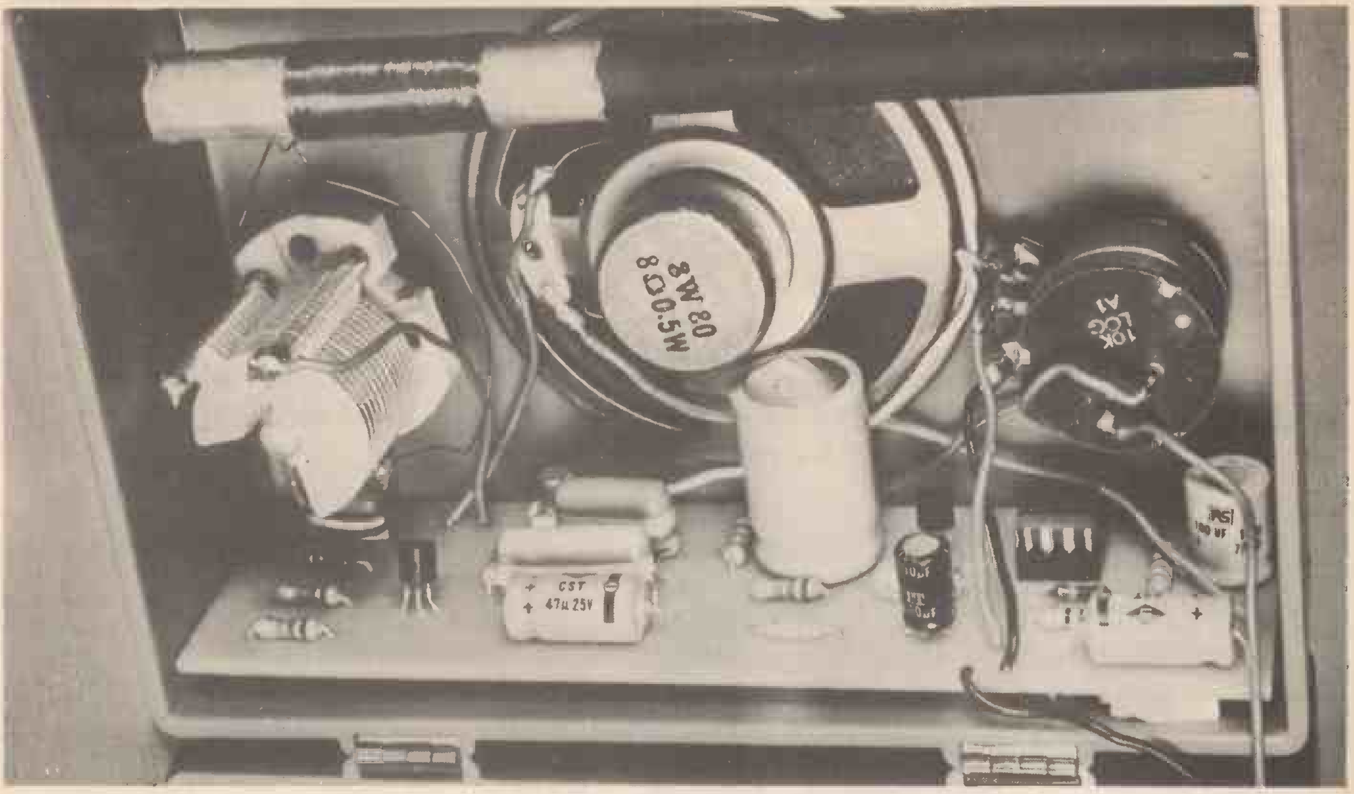
TURN ON TIME

Once you are sure that there are no wiring errors, turn on the radio. You should hear something coming from the loudspeaker. Adjusting the tuning should bring in quite a few stations in the MW band, the exact stations depending on your locality and the time of day. The ferrite rod provides a very directional response for the bedside radio and the receiver should be rotated for maximum output from each station.

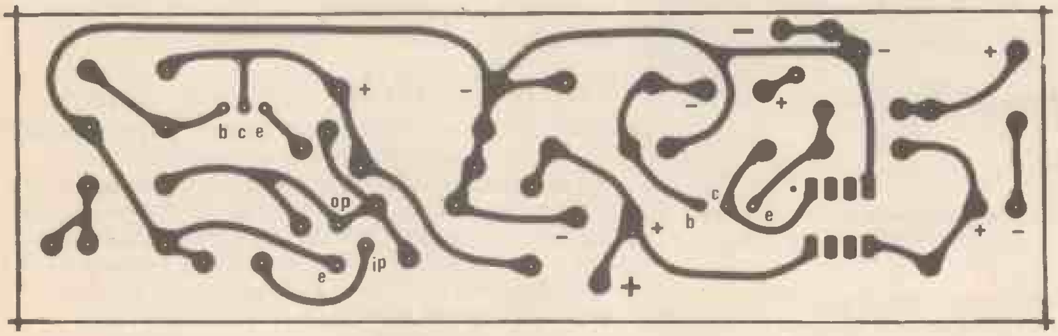
Unless you are very lucky do not expect to walk into your local shop and pick up all the pieces for the radio. You will probably have to use the services of a mail order firm. Some of the larger firms will be able to supply nearly all the Radio's parts and even if some of their individual prices are higher than some others quoted in the magazine, remember the savings in postage with one stop shopping . . .

The file case we use for the Radio is available from branches of Rymans.

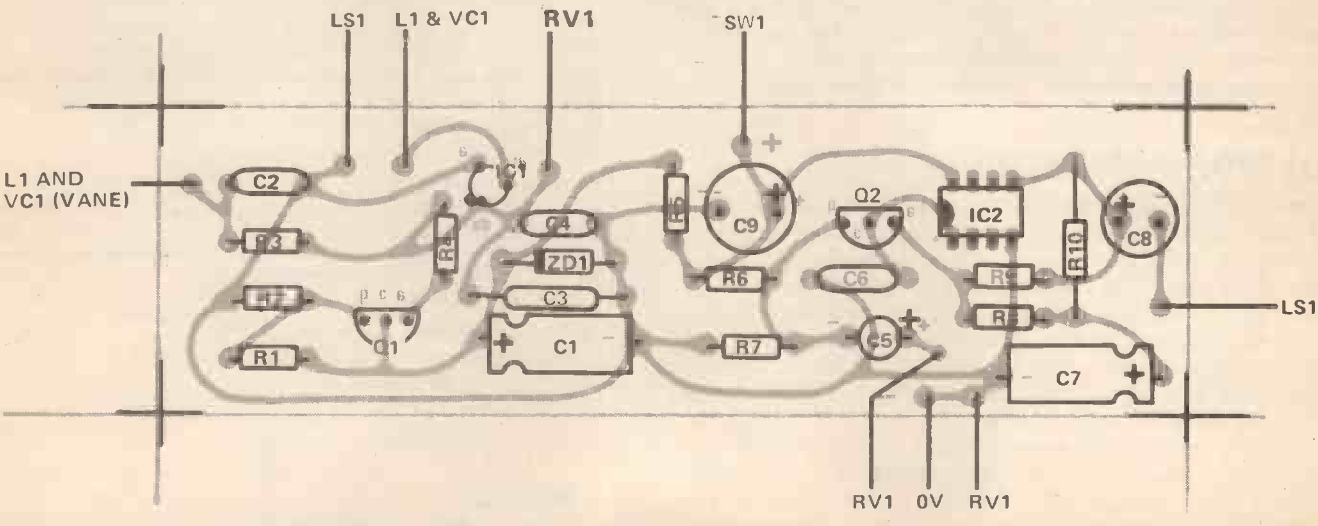




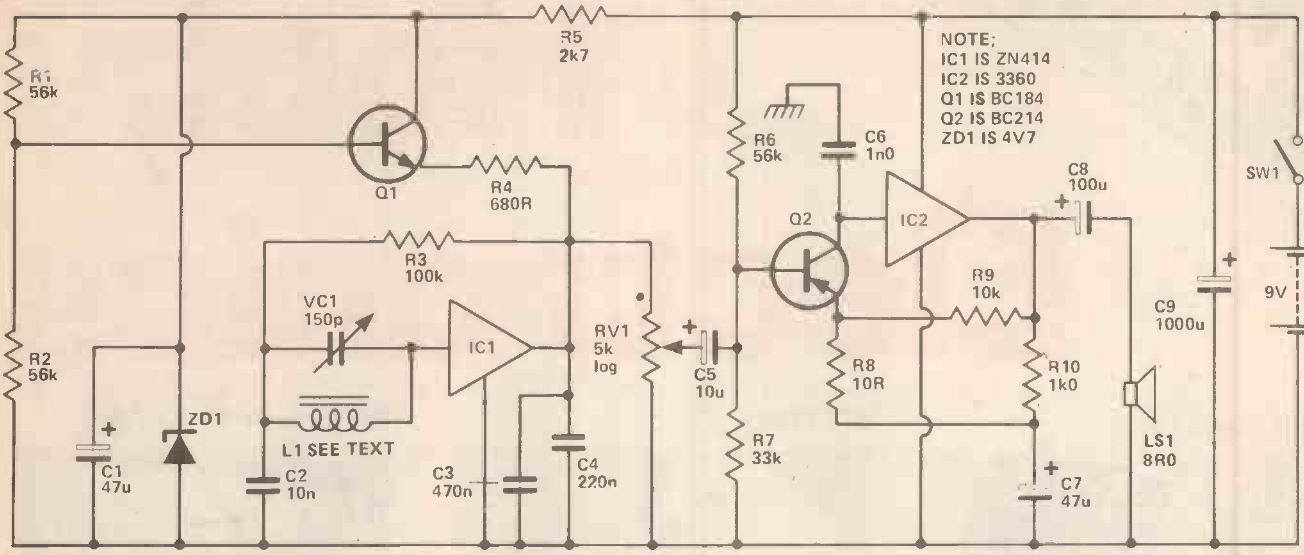
Close up view of our prototype, the aerial can be seen, near the top, we fixed it in place with 'sticky pads' which you can probably get from the same shop you get the box from — the PCB was also held in place in the same way, as was the battery! Useful things are 'sticky pads'!



The pattern for the printed circuit board (PCB), you can make one yourself (see narticle in this issue), or buy one from one of the firms advertising them. Shown full size (40 x 135mm).



How to position the components on the PCB, make sure the transisters, intergrated circuits, diode and electrolytic capacitors are the correct way round before soldering in place. Terminal pins can be used where leads need to be taken from the board.



Circuit diagram of the complete Bedside Radio, winding details for LI (the aerial) are given in the main text, although an 8 ohm speaker is specified a higher value can be used (but you will get reduced volume).

How it Works

The bedside radio is a MW AM radio, the first initials standing for Medium Wave and referring to the band of frequencies within the Radio Frequency (RF) spectrum that the radio is sensitive to, the second standing for Amplitude Modulation. This term refers to the way in which the signals that the bedside radio is designed to receive are transmitted. In an AM system the transmitter will produce a continuous carrier wave at a particular frequency within the MW band. The strength or amplitude of this carrier wave will then be made to vary according to the level of the signal to be broadcast.

The radio signal is picked up by L1 which together with VC1 forms a parallel tuned circuit. By varying the value of VC1 this combination can be made to resonate at different frequencies in the MW band. This provides the means by which we can select one particular station amongst the many transmitting at any one time. The resonant circuit will only pass to the following stages signals operating at or near its resonant frequency.

IC1 is a ten transistor Tuned Radio Frequency radio receiver. The RF signal from the aerial circuit is fed to its input and the audio signal corresponding to the particular station selected appears at its output.

Q1 supplies power to IC1 together with R4, while R3 sets the characteristics of the Automatic Gain Control (AGC) also included inside IC1. C3 and C4 remove any RF that is still present at the output of IC1.

The audio signal is fed via the volume control RV1 and capacitor C5 to the power amplifier formed by Q2 and IC2. This stage increases the level of the audio signal so that we can drive the loudspeaker LS1. Resistors R8-10 and C7 act as a fixed tone control.

ZD1 is a zener diode in conjunction with R1, R2 and C1 it ensures that the radio's supply is a stable 4V7.

Parts List

Approximate cost: £6

RESISTORS	
R1, 2, 6	56k
R3	100k
R4	680R
R5	2k7
R7	33k
R8	10R
R9	10k
R10	1k0

CAPACITORS		
C1, 7	47u	16V electrolytic
C2	10n	polyester
C3	470n	polyester
C4	220n	polyester
C5	10u	16V electrolytic
C6	1n0	polyester
C8	100u	16V electrolytic
C9	1 000u	16V electrolytic

SEMICONDUCTORS	
Q1	BC184L
Q2	BC214L
ZD1	4V7 400mW zener diode
IC1	ZN414
IC2	MC3360

POTENTIOMETER
RV1 5k0 logarithmic

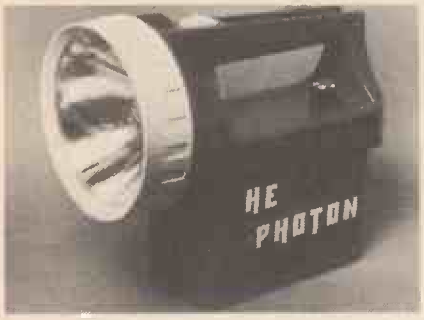
VARIABLE CAPACITOR
VC1 150p (Jackson type C.804)

MISCELLANEOUS
PCB as pattern, card file box, 2½", 8 ohm loudspeaker, ferrite rod (5¼" x ⅜" dia.), 32 SWG wire, PP9 with clips, knobs, connecting wire etc.

Next Month

Hobby Electronics

Light Beam Phone



True wire-less communication for which you don't need a licence! Our project next month — which we are calling the 'HE Photon Phone' uses two standard torches which we've converted — all the electronics fit into it beautifully. In our tests we've been able to make our units work over a distance of 50 feet; even if you don't want to build it, you'll be fascinated by the techniques there's even a remote control facility included.

Audio Mixer Project

A really neat project designed by a professional audio engineer — that's a quick summary of our mixer, choose your own number of inputs (we've opted for three high level and two low level ones). There's a bass and treble control and of course a master level control. Building it should be simplicity itself as everything, including the level controls is on a single printed circuit board. Power is supplied by two PP3 batteries; inputs and outputs are via standard jack sockets.

Bias

No — not political, tape. Why do you need a high frequency signal added to a tape recording — you never hear it so why is it necessary? Next month we tell you.

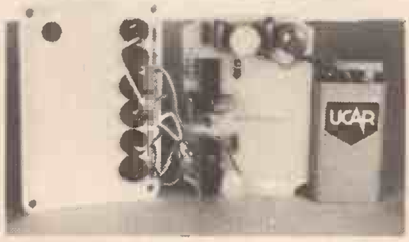
DIY PCB's

The neatest way to build a project is on a PCB — few would deny that, yet PCB's are frightening to those who haven't tackled them before. Next month we will be launching Hobbiprints — a really easy way to make the PCB's which we show in HE and we'll show you how to use them.

Calculators

The world of calculators has gone the way of HiFi — the facilities offered often cause confusion. We take a look at the current terminology of the calculator market enabling you to find out if the facilities offered are really the ones you want.

Electronic Dice

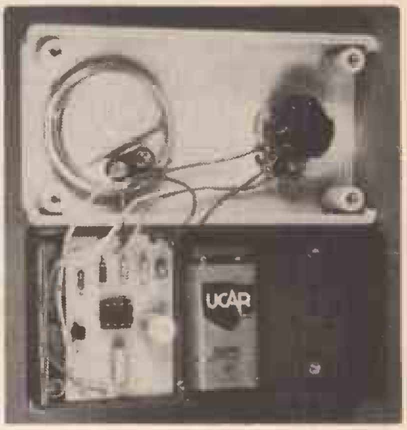


Press the button and one of six LED's comes on at random. From the photograph you can see this is really a straightforward project. The light stays on automatically — there isn't even an on-off switch!

The Tesla Controversy

Nikola Tesla was without doubt a genius — he even has a unit of measurement named after him — but even 35 years after his death there are those who believe that much of his work has been suppressed.

Metronome



Using just a single 555 IC, this project can be built on either a PCB or Veroboard — we give you details for both. The beat rate can be varied from 30 to 120 beats a minute.

SPECIAL OFFER

Next month you'll be able to get a top quality soldering iron, either 240V or 12V, through our offer in HE. Today's regular price is £4.00 but next month you can get this for:

£2.35 inc.

The December issue will be on sale on November 10th

The items mentioned here are those planned for the next issue but circumstances may affect the actual content.

REVIEW

"Have you got what it takes to be an electrical engineer?" This is the question asked by a rather over-enthusiastic but otherwise excellent tape-slide presentation for schools produced by STC and the IEE (that's Standard Telephones and Cables and the Institution of Electrical Engineers).

It's aimed at the 12-16-year-olds and hopes to convince them to become graduate electrical engineers.

It's based around three young graduate engineers and comprises mainly of their own commentaries about the work that they do. The three have obviously been picked very carefully: they include one woman and one Sri Lankan. All three are doing worthwhile jobs in the development and commissioning of telephone exchange equipment (with STC, presumably).

The reason for choosing young people seems obvious: it is hoped that the children to whom this presentation is shown will identify with them. Unfortunately, the jobs they do come over as incredibly complex and possibly a little frightening (to a 12-year-old, anyway). They are all professional engineers moving quickly up their respective ladders and this, combined with a very slick production (additional commentary by Michael Rodd of "Tomorrow's World"), makes one wonder what sort of kid *would* identify with them. Certainly not the child who hadn't previously considered engineering as a profession: The presentation seems to be geared to steering eventual engineering graduates towards electrical engineering, rather than the uncommitted towards engineering. It's interesting to note that all three 'sample engineers' seem to have been interested only in the hard sciences at school and to have taken engineering at University as a reflex action.

Surprisingly, the script also upholds the old image of the scientist/engineer, dedicated totally to his job (one of the sample engineers tells us that he spends about three-quarters of his (waking) life working; dealing with enormous mountains of machinery (although admittedly very high technology); not having much contact with people (none of the three is shown attending a meeting). The only major improvement is the emphasis on the woman engineer. Here, however, it comes out on top — it is made perfectly clear that women engineers are fully accepted by their colleagues and are becoming more and more common in industry. (It is hoped that the material dealing with women will have some effect on the teachers as well as the pupils!)

The tape/slide presentation lasts about 20 minutes and is available as:

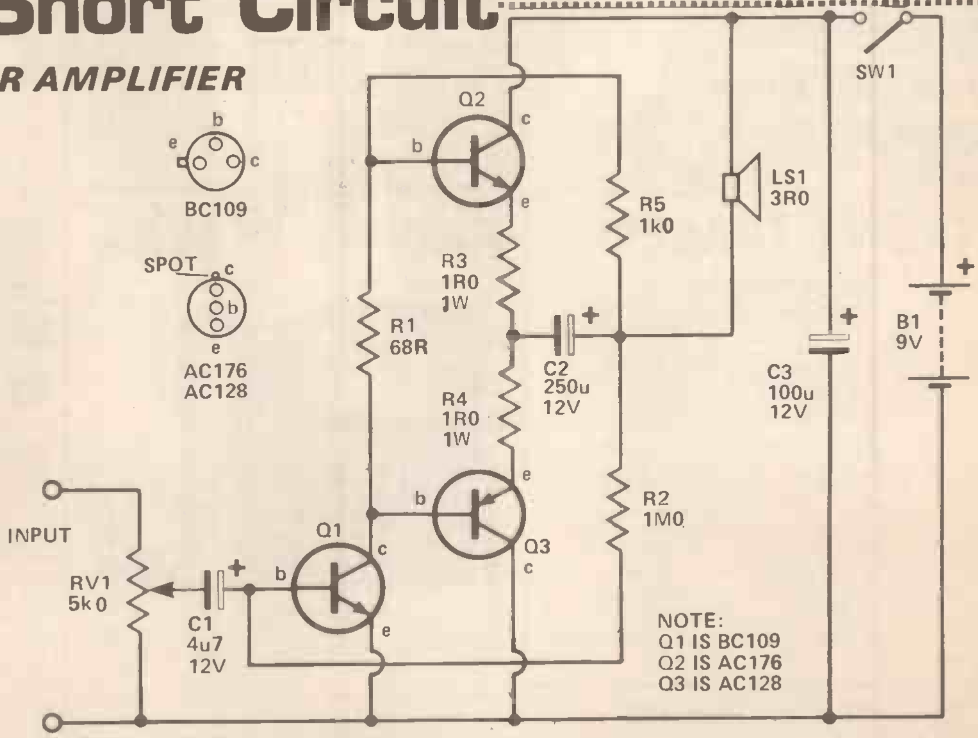
a double-carousel autocue version,
a single-carousel autocue version or
a set of slides, a tape and a marked script.

It comes with a set of leaflets for distribution amongst the audience and is available on free loan from: Mrs. Diane Winfield, The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL.

PHIL COHEN

Short Circuit

TRANSISTOR POWER AMPLIFIER



Most of the Hi Fi amplifiers in use are based on circuitry similar to this design, although they are much more sophisticated. The circuit uses a 'complementary' output stage, with one NPN and one PNP power transistor, which eliminates the need for an output transformer found in old amplifier designs.

Output power is close to 1W, with reasonably low distortion. The input signal is passed through the volume control RV1 and then via C1 to the base of Q1. The collector load for Q1 is composed of R1, R5 and the loudspeaker and the voltage at the collector will be about half the supply voltage, i.e.: 4V5. The bases of Q2 and Q3 are also at the same voltage (very nearly) as the collector of Q1 because the value of R1 is so low (68R).

At the junction of the emitters of Q2 and Q3 the voltage will also be very nearly 4V5, R3 and R4 and very low value resistors to limit the current through Q2 and Q3. When the amplified input signal is less than 4V5, Q2 is turned off (as the base will be at a lower voltage than its emitter), but Q3 will conduct the signal. When Q1 amplifies the signal to above 4V5 the reverse happens, Q2 conducts and Q3 is turned off.

The signals are combined at the the common emitter junction of Q2 and Q3, and passed to the loudspeaker through the large electrolytic capacitor C2. Small values of C2 result in a poor low frequency response. Negative feedback is provided by R5 and R2, these ensure stability by reducing the gain slightly. R1 is included to provide a small amount of base bias for Q2 and Q3, more sophisticated designs use thermistors or diodes to prevent 'thermal runaway' which can destroy the output pair.

A disadvantage is the DC coupling of the transistors, if one transistor alters its characteristics the result can be catastrophic! For this reason, the output pair should be a 'matched pair', other types can be tried as long as they are also "matched pairs".

electronics today international

What to look for in the December issue: On sale Nov 3rd

ETI LIGHT SHOW

HANDS UP all those who've never been to a disco. None? Good — that means you've all seen sound-to-light units in action, although it's more than likely it was a normal three-channel affair. Usually boring, are they not?

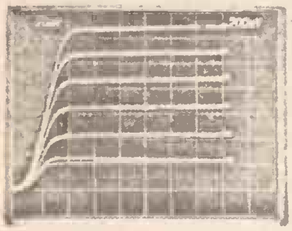
Well ETI plans to change that next month; ours has five frequency channels, with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straight sound to light, or have it strobe all lights. At a speed dependent upon music level (not volume — the unit is independent of that!) or hand over control to an internal digital circuit which produces some superb random effects. If you fancy a five colour manually controlled strobe unit it can do that as well!

Each channel handles up to 500 W of lighting, and a complete kit of parts will be available from Powertran, who designed this project especially for ETI.

Electronics in Model Railways

An essential part of the education of any young man is his electric train (checking with ETI technical staff shows all eight had one — and five still have). Most of us however remember the controls as crude; today things are changing — sophisticated electronic controls are perfectly suited to model railways and the manufacturers are about to announce some dramatic advances. We take a look at what's happening.

CURVE TRACER



Explaining the shape of Voltage-Current characteristics of diodes, transistors and other non-linear devices is usually dull as it normally involves a tedious plot of static, experimental data.

A more elegant solution is available to anyone with a DC coupled scope capable of taking an external X-input. Next month we carry a project with the additional circuitry necessary to do this yourself.

How It Works

In the November issue we begin a new type of article. The idea came to us when discussions with experts in one area of electronics admitted to almost total ignorance of other areas — especially commercial circuitry. Mass-produced electronics use techniques which are not widely understood elsewhere — we hope to put that right. In the first of this occasional series we have asked Gordon King to discect a Thorn Monochrome TV; we shall show the complete circuit and explain the function of each stage. It's *not* done as a beginners series but to give those outside this field the true "Inside Story."

Car Anti-theft System

A simple project to build but sophisticated in its operation. It is a comprehensive system that incorporates several features of large and expensive commercial systems and using state-of-art techniques it is extremely reliable. A kit will be available of the whole project.

INDEX

A complete listing of all we've carried in ETI since our last Index which was carried in April 1977) and went back to the first ever ETI). As our research shows that 96% of readers never throw away their copies it should be useful to most of you.

computing today No.2

Win a TRITON Computer

Want to get your hands on a Triton Computer Kit but can't afford it (yet)? In No. 2 of our new supplement Computing Today, we have a free-entry competition for one to be won. If you've read this far you'll probably know what it's worth — but in case you don't it's about £300

Microprocessors by Experiment

Learn about microprocessors — not from some abstract description of a make believe MPU but by hands on experience with an MPU system. The series, based on the MK14 development kit, will take you through the operation of the SC/MP MPU and show you how to use it to do everything from control your heating system to land on the moon.

I/O for 6800

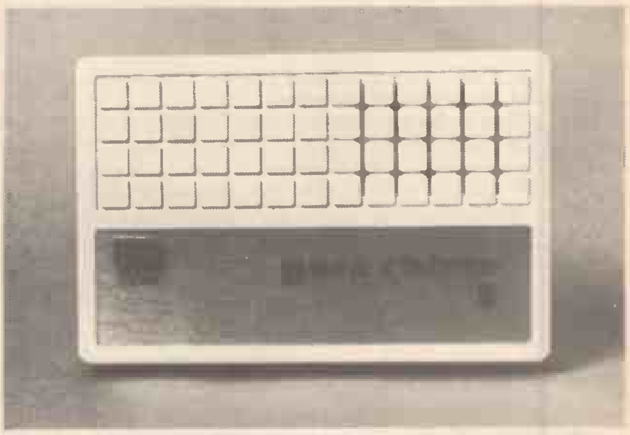
The microprocessor user rapidly arrives at the need to understand and apply input/output circuitry to interface peripheral equipment to the computer system. A standard choice, when using a 6800 microprocessor, is to employ a Peripheral Interface Adapter (PIA). Many engineers now buy ready-built systems then wish to utilise the PIA as straightforward outputs and inputs. When data sheets are consulted they are found to give concise yet complete hardware and software information. The user of a ready-built system needs help in simply getting the PIA to act as outputs and inputs without becoming involved in the intricate details needed by designers of microcomputer boards. This article aims to give this help.

Features mentioned here are in an advanced state of preparation as we go to press but circumstances may affect the final contents of the next issue.

Kit Review

—THE 'DORA CHIME'

If you are getting bored with the same old "ding-a-ling," why not try building the ultimate in door chimes! Jim Perry reviews the Doram Dora Chimes, computerized door chime kit.



THE WORLD OF THE humble door bell was given a kick into the forefront of technology with the introduction of a dedicated microprocessor doorchime. The original unit was developed about a year ago (by Chromatronics), and sold as a pre-built unit with any of 24 different tunes available, at the touch of a bell push. Doram Electronics have introduced a simpler version, with up to 8 tunes available, and supply a complete (except for batteries) kit of parts — the Dora Chime 8.

The microprocessor used is the same one as used in the 24 tune commercial version (in fact the kit was designed by Chromatronics for Doram). By making the constructor choose a set of tunes (1 set from 3), at the construction stage (with a wire link) a switch is eliminated. Also the volume is not variable, it is fixed at loud (very), this eliminates another control. With the removal of these two controls the unit has been made to fit inside a smaller than usual box — and is cheaper (£12.95).

FIRST IMPRESSIONS

The kit arrived in an expanded polystyrene container, inside the normal paper packing. With this sort of protection it was not surprising that the contents were intact. The hardware, components and microcomputer were all packed in separate plastic bags — a good idea; some companies still cram everything into the same bag, and expect the buyer to sort it out. The instruction leaflet started with preliminary instructions (check off the contents, what tools you need etc), then followed with 17 steps in construction. The 17 constructional stages are followed by a short fault finding guide and what to do if it still will not function.

Overall, the initial impression was of a well thought out and packaged kit. Next stage was to actually follow the instructions and see if they were correct.

GETTING IT TOGETHER

After identifying all the components came the seemingly straightforward task of inserting them. The first hitch came with a resistor, R8 in fact. On the printed circuit board there was no indication of where it should fit — the correct position was finally found by reference to an illustration in the instructions.

The three tune sets that are available from the Dora Chime 8

	LK1 'A'		LK1 'B'		LK1 'C'
1	Oh Come All Ye Faithful	1	Soldiers Chorus (Faust)	1	Mozart
2	Oranges and Lemons	2	Twinkle Twinkle Little Star	2	Colonel Bogie
3	Westminster Chimes*	3	Great Gate Of Kiev	3	Wedding March (Mendelssohn)
4	Sailor's Hornpipe	4	Red Flag/Maryland/Tannenbaum	4	The Lorelei
5	Land of Hope And Glory	5	William Tell Overture	5	Toccata in D Minor (Bach)
6	Rule Britannia*	6	Beethovens Ode To Joy (9th)	6	Deutschland Uber Alles
7	God Save The Queen	7	The Stars & Stripes*	7	The Marseillaise
8	Greensleeves	8	Cook House Door	8	Beethoven's "Fate Knocking"

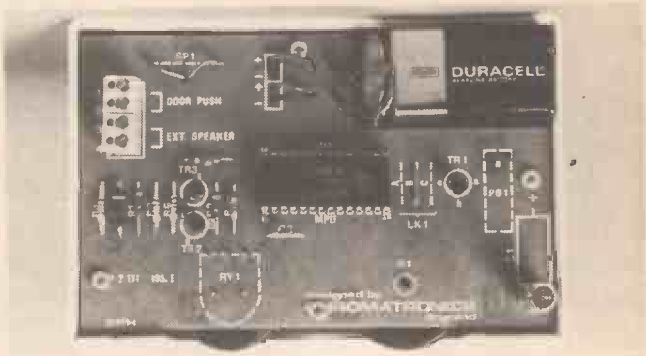
The rest of the construction was reasonably straight forward. Total construction time was half an hour.

After checking everything over, the moment of truth — it wouldn't work. With the aid of the fault finding guide, it became apparent that I had inserted the microcomputer back to front (shame on you!-Ed). Crossing fingers, the device was removed and repositioned correctly — it worked!

CONCLUSIONS

The Dora Chime 8 is a good kit, they have tried to make it as idiotproof as possible (hence the non-destruction of the wrong way round microcomputer!) and succeeded. The only things they don't supply are batteries and tools — it is assumed you have an existing bell push also.

If you know which end of a soldering iron to hold, and want some experience in building, then the kit should present no problems — the hardest part is deciding on the tune selection! HE



Above right is the kit unpacked from its box, separate bags were provided for all the major items.
Below right is the completed Dora Chime with its back off, note that option 'B' was chosen in the Unit we built up.

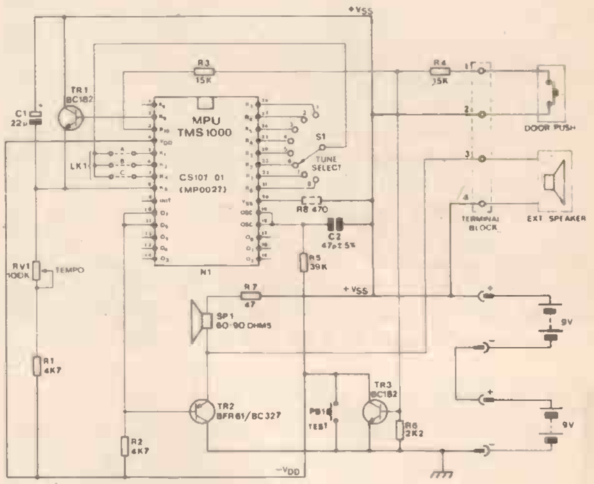
The Dora Chime 8 is available from Doram Electronics Ltd, P.O. Box TR8, Wellington Road Estate, Wellington Bridge, Leeds LS12 2UF. Price is £12.95 inclusive of VAT and postage.

How it Works

The microprocessor used in the Dora Chime is a TMS 1000, manufactured by Texas Instruments. Most microprocessors use external devices to store instructions and data, the TMS 1000 does not require an external store—it has one built into it during manufacture. The inbuilt store is called a Read Only Memory (ROM), and it holds all the computer instructions needed for the device to play the various tunes. ROM data is divided into the actual program (to tell the device how to find out which tune to play etc). and data (which notes go where, in each tune). The ROM is configured as 1024 words (bytes in computer jargon), with each word having 8 letters (bits)—because it is a computer each letter is either a zero or a 1 (a low or high voltage). All the information in the ROM is fixed at the manufacturing stage—the TMS1000 is a 'dedicated' microprocessor; by using a different set of data in the ROM it can be used for another purpose, but a door chime device will not work in a washing machine circuit (and vice versa).

Tune selection is with the use of a wire link from pins 5, 6, or 7, and an eight way switch connecting the selected pins to one of pins 21 to 28 on the TMS1000. The tempo is varied with the adjustment of RV1 (a 100k potentiometer), the lower value the faster the tempo.

When the door push is pressed a connection is made from Vss (positive) to the base of TR3, via a 15k resistor (R4). The transistor switches on and connects Vdd (negative) supply to the main

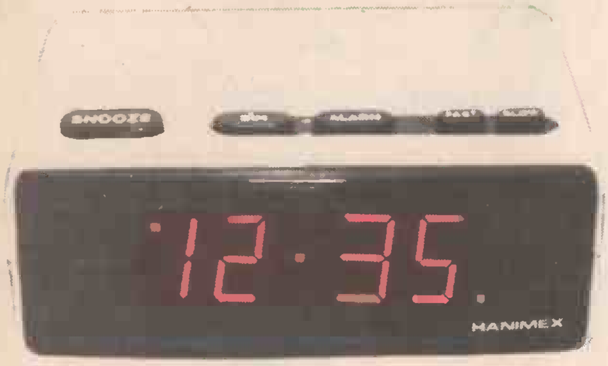


circuitry. As soon as power is applied to the TMS1000 it starts its program, and pin 3 becomes a high (Vss) voltage. Pin 3 is connected via another 15k resistor (R3) to the bse of TR3, this is to keep the supply to the TMS1000 until the program is completed.

The microprocessor checks to see which tune has been selected, and replays the data to match. The computer data is converted into a series of tones by pulsing pins 10 and 11 with voltage. This pulsed voltage drives the loudspeaker via TR2.

Hobby Electronics

Marketplace



Size: 100mm x 130mm x 60mm.

Over 10% of Electronics Today International's readers have purchased a digital alarm clock from offers in that magazine — the offer is now extended to Hobby Electronics readers. This is a first rate branded product at a price we don't think can be beaten.

The Hanimex HC-1100 is designed for mains operation only (240V/50Hz) with a 12 hour display, AM/PM and Alarm Set indicators incorporated in the large display. A switch on the top controls a Dim/Bright display function.

Setting up both the time and alarm is simplicity itself as buttons are provided for both fast and slow setting and there's no problem about knocking these accidentally as a 'locking switch is provided under the clock. A 9-minute 'snooze' switch is located at the top.

An example of this digital alarm clock can be seen and examined at our Oxford Street offices.

£8·95

(Inclusive of VAT and Postage)

We feel we've got to tell you carefully about this offer which we're introducing for the first time. Why? Because our price is so enormously lower than anywhere else you may suspect the quality.

The exact same watch is currently being offered by another magazine as a special at £24.95 — some of the discounters are selling it at £29.95 the price to HE readers for exactly the same watch is £12.95.

The display is LCD and shows the seconds as well as the hours — and minutes — press a button and you'll get the date and the day of the week.

Press another button for a couple of seconds and you have a highly accurate stopwatch with hundredths of a second displayed and giving the time up to an hour. There is a lap time facility as well — and of course a back light.

Our Chrono comes complete with a high grade adjustable metal strap and is fully guaranteed.

An example of this LCD Chronograph can be seen and examined at our Oxford Street offices.

£12·95

(Inclusive of VAT and Postage)

DIGITAL ALARM

To:
DIGITAL Alarm Offer,
Hobby Electronics,
25-27 Oxford Street,
London W1R 1RF.

Please find enclosed my cheque/P.O. for £8.95 (payable to Hobby Electronics) for my Digital Alarm Clock.

Name . . . .

Address . . . .

. . . .

. . . .

Please allow 14 days for delivery.

LCD CHRONO

To:
LCD Chrono Offer,
Hobby Electronics,
25-27 Oxford Street, London W1R 1RF.

Please find enclosed my cheque/P.O for £12.95 (payable to Hobby Electronics) for my LCD Chronograph.

Name . . . .

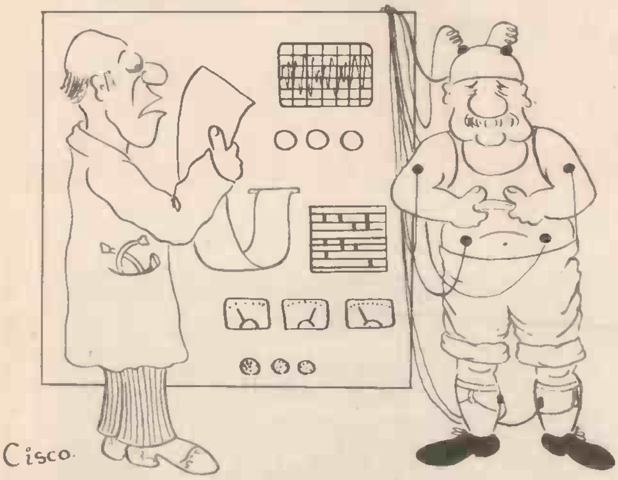
Address . . . .

. . . .

. . . .

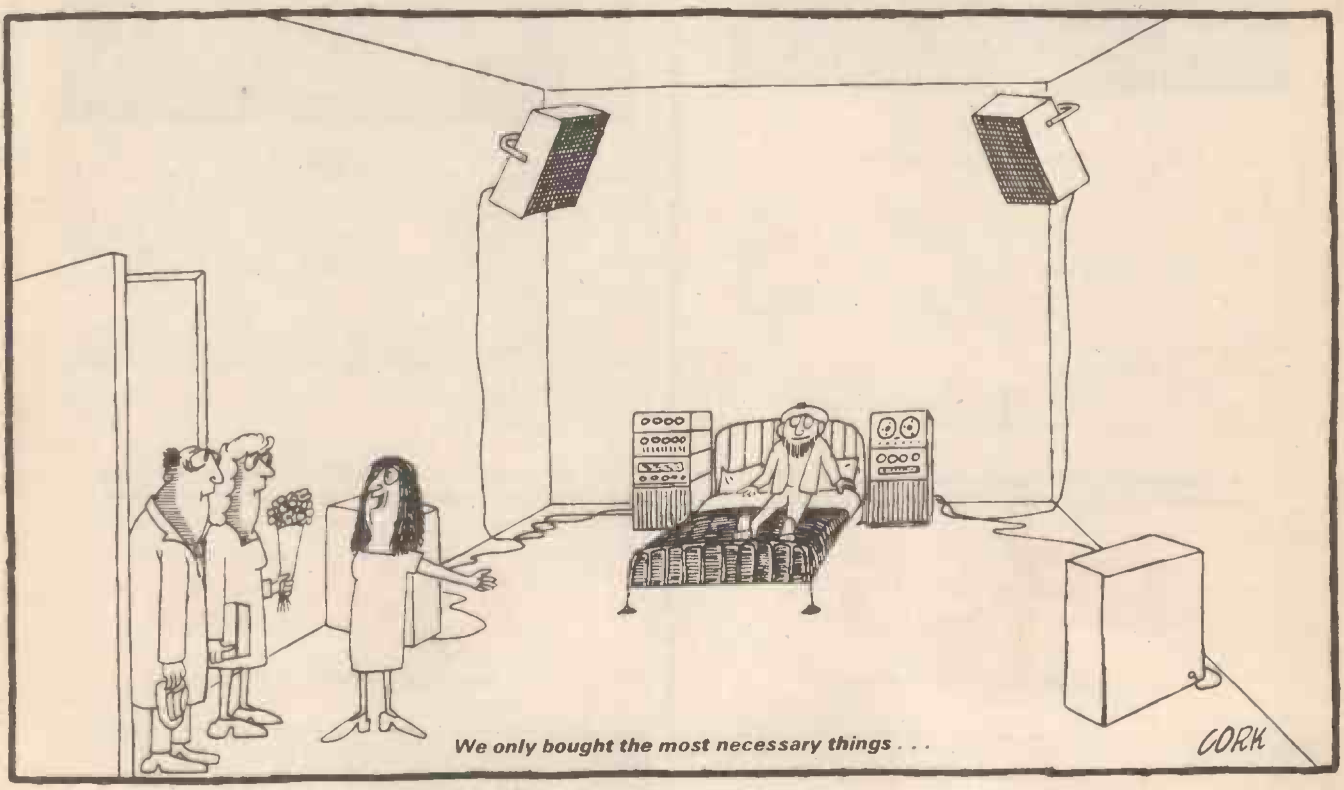
Please allow 14 days for delivery.

HE-HE!

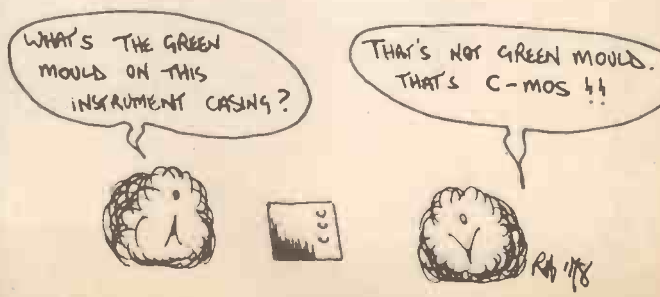


According to the computer you're four months . . . guess what!

After 50 years of ships in bottles I wanted more of a challenge.



We only bought the most necessary things . . .



Transducers —IN AUDIO

Transducers—the things which convert electronic signals into other forms—are at their subtlest when that other form is sound.

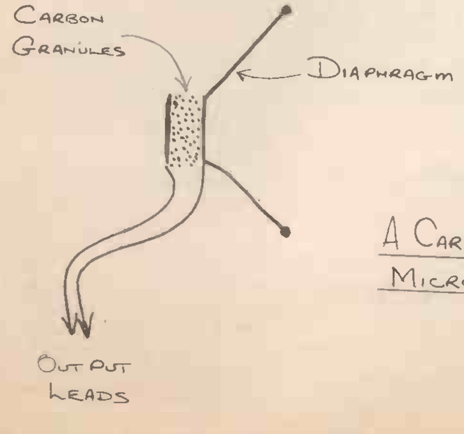
"MR WATSON, COME HERE, I want you . . ." No, not a line from an Arthur Conan Doyle novel, but the world's first telephone message sent by Alexander Graham Bell to his assistant Thomas Watson.

Bell had invented the telephone, or, to be more precise had developed the first practical audio transducers. The telephone consists basically of a microphone, earpiece and some connecting wire between them. Electric wire was not a new invention — the important developments were the transducers at its ends, which converted the sound into an electrical signal and back to sound again. The development of 'microphones' was hampered in Bell's day as any form of electrical amplifier could not yet be constructed. This meant that the technology was limited to producing microphones with a sufficiently large enough output to drive an earpiece directly.

Advances in technology since Bell's day (the invention of amplifying devices like the valve and transistor) mean that today we have a wide variety of audio transducer operating on a variety of different principles.

SOUND DEVELOPMENTS

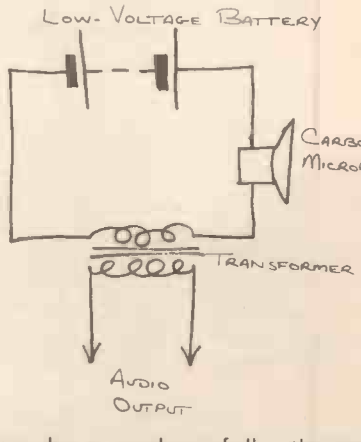
Taking transducers which convert sound into electrical energy first (although in some case devices can be used as either microphone or loudspeaker units), these can be divided into two main groups. These groups are devices which respond to sound by changing one of their electrical properties and devices which directly produce an electrical signal as an output. The carbon microphone is one of the first group. It is found universally in telephone hand-sets, although it was not the type used by Bell in his first system.



A Carbon Microphone

Bell's original transducer!

The carbon microphone consists of a diaphram, two electrodes and packed carbon granules. Normally the resistance between the electrodes through the carbon is a constant value of a few hundred ohms. When the diaphragm vibrates with incident sound, the spacing between the carbon granules changes. As they are forced closer together the resistance decreases and as they space out more the resistance increases. The resistance of the microphone thus changes with incident sound.



Circuit For Using A Carbon Microphone

To make the microphone work usefully, the varying resistance must be converted to a varying electrical signal. This can be done quite simply by putting the microphone in series with a low voltage DC power source (could be a battery) and a transformer. As the resistance of the microphone varies, so too (from ohm's law) will the current through it. The current through the primary winding will also vary, and a similar changing signal will be induced in the secondary.

This type of microphone does not provide a high quality signal — it is really only suitable for speech, and is also not particularly sensitive — you have to talk quite near to it. Despite these two drawbacks, the carbon microphone is ideal for use in telephones, although there is some talk of it being replaced by electret microphones.

CONDENSATION

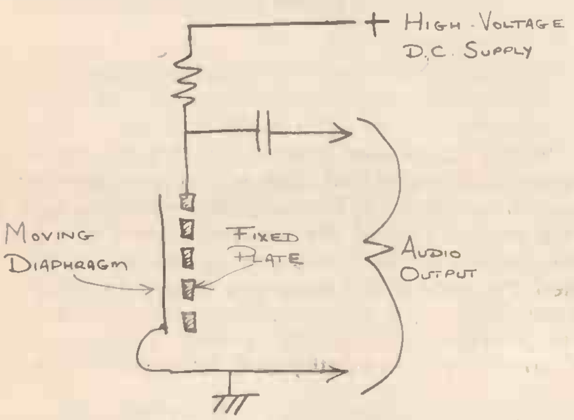
The other important type of microphone which fits into the same category as the carbon microphone is the capacitor (or condenser) microphone. These devices can be again divided into two groups.

As its name may suggests, the capacitor mike provides an output in the form of a varying capacitance.

Essentially the device consists of two parallel metal plates separated by a small air gap. One of these plates is rigid but perforated, the other is thin and flexible. The thin plate is able to vibrate in sympathy with incident sound. As it does so, the distance between it and the other plate varies. The two separated plates are essentially the basis of a capacitor. The capacitance being given by the formula

$$C = \frac{EA}{d}$$

where C is the capacitance, E a constant, the permittivity of air, A the area of the plates and d the distance between them. As the distance (d) between the plates varies, it follows that so too will the capacitance.



Circuit For Using A Condenser Microphone

Changing this varying capacitance into an electrical signal is quite a problem as the capacitance of the plates can be as low as 30p (3×10^{-8} farads) and the maximum change only about 3p. Producing the varying voltage is done by applying a high voltage to the plates through a large value resistor. This voltage can be anything from 60 volts upwards, depending on the model of microphone.

When the capacitance changes with sound striking the plates, the charge on the plates will remain constant but the voltage between will vary (this follows from the formula Q=CV, Q, the charge on the plates is constant, so as the capacitance, C, changes the voltage, V, will vary inversely). This varying voltage forms the output.

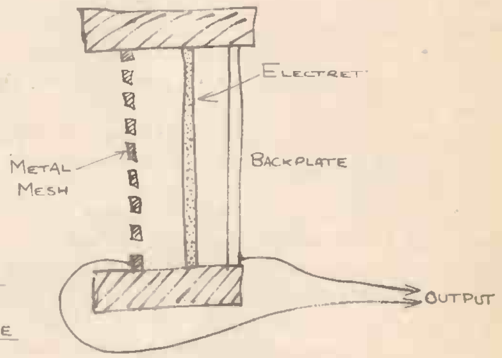
The output from the actual microphone capsule is of a very high impedance and if it were connected directly to a cable, the signal would be severely deteriorated over even a few feet. It is thus necessary to have a small preamplifier very close to the capsule. This is usually in the body of the microphone, normally only a couple of centimetres away from the capsule. The preamp has a very high input impedance, a value of 200M (200 million ohms) being a typical figure.

Capacitor microphones are very high quality, very fragile, and very expensive. They are also very flexible. By having two flexible plates, one either side of the rigid plate, and by altering the polarising voltage to the plates, the characteristics of the microphone can easily be changed.

ELECTRETS

A variation on the capacitor microphone is available which does not need the high voltage polarising supply. Elecret microphones are manufactured with a slab of electret material between the two capacitor plates. Electrets are specially manufactured substances which carry a permanent charge. This permanent charge removes the need for the high voltage supply, but a low voltage supply is still required to power the preamplifier. This is usually obtained from a battery housed in the microphone body.

Section Through An Electret Microphone



Electret microphones are much cheaper than the normal capacitor types. The quality of the microphone is not quite as good, but at about 1/10 of the price, this is really only of concern to a professional user.

Many portable cassette recorders have electret microphones built in.

CRYSTAL CLEAR

Crystal microphones work on the piezzo-electric effect. When crystals of some chemical salts are physically distorted, a voltage appears across two of its faces. The crystal microphone uses this principle — a diaphram is linked to the crystal. When sound waves make the diaphram vibrate the crystal is distorted and metal contacts are used to make connection to the crystal faces.

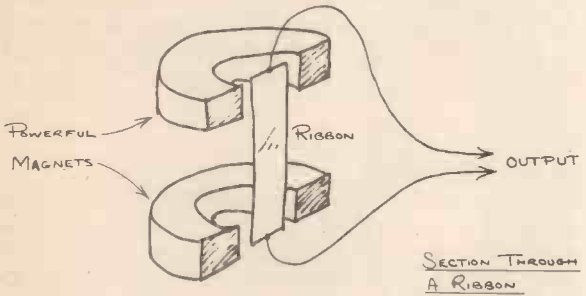
Crystal mikes are very poor quality but do provide a high output.

TOILING COILS

If a wire is moved at right angles to a magnetic field, then a current will be induced in the wire perpendicular to both the magnetic field and the movement.

This principle is also used in some types of microphone. In its simplest form, a ribbon is suspended between the poles of powerful magnets. Leads are connected to the top and bottom of the ribbon.

When sound strikes the ribbon, it will vibrate to and fro between the poles of the magnet and a current will flow along it and through the connected wires.



Section Through A Ribbon Microphone

The signal generated by the ribbon is very small. Any length of wire to which it is connected would have a resistance large enough reduce the signal quite considerably. For this reason a transformer is always mounted inside the microphone. The transformer increases the impedance and voltage of the ribbon's output so that any connecting wire has less attenuating effect. For obvious reasons this type of microphone is called a ribbon mike.

The actual ribbon is very fragile and has to be well screened from winds (or heavy breaths) making it unsuitable for outdoor use. If a coil of wire were used instead of a ribbon (in a different mechanical assembly) the output would be much higher. This is done in the common 'dynamic' microphone. A diaphram is attached to a coil which vibrates in the magnetic field. The mechanical construction of this type of microphone is much more rugged as there is no longer a thin vulnerable ribbon.

However, the mass of the diaphram and coil is much higher than that of just the ribbon. At high frequencies this extra mass makes it harder for the sound to vibrate it and there is less output.

Thus, by making the device more rugged other problems are encountered. The poorer high frequency response could be overcome by making the coil and diaphram smaller and lighter. This would unfortunately affect the low frequency response.

A solution offered by some microphone manufacturers is to build two microphones into one body. One has a large diaphram, and the other a much smaller one. These two-way microphones however, are much more expensive.

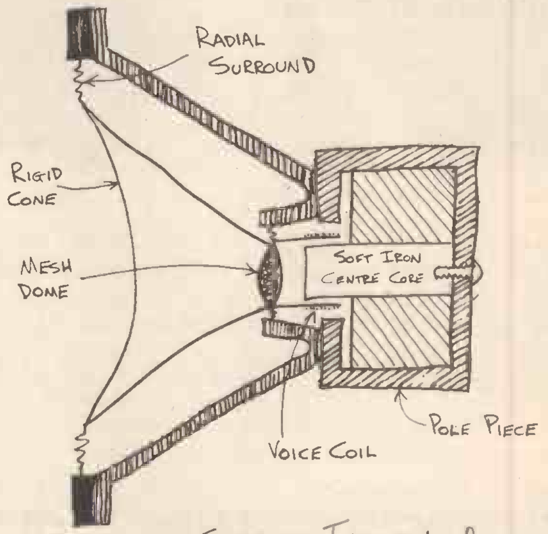
The first microphone used by Bell was one of the magnetic induction type and not the carbon type by the way. The output from it was very low, and as amplifiers did not yet exist, the sound reproduced at the receiving end very faint.

MISTER SPEAKER

It would be logical to assume that if microphones produce an electrical signal when excited by sound, they should produce sound when an electrical signal is applied.

The theory behind this does in fact support this assumption to all the microphones mentioned except the carbon microphone.

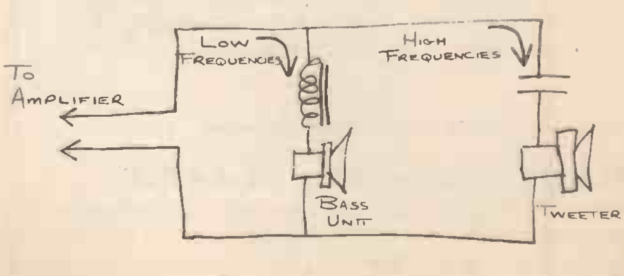
In practice however, the requirements of an electric to sound transducer are such that mechanical design of loudspeaker and earphones is different.



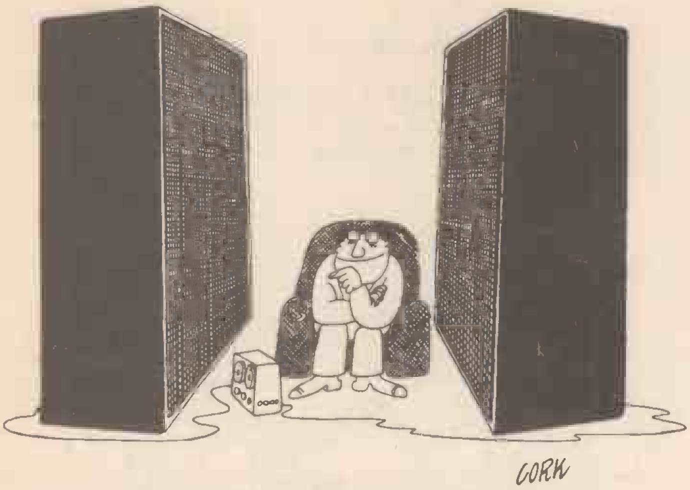
Section Through A Moving Coil Loudspeaker

The moving coil loudspeaker consists of a paper cone attached to a fine coil of wire, which is suspended in a strong magnetic field. The edge of the cone is attached to the metal frame of the speaker so that it is free to move. When an electric signal is applied to the coil (called the voice coil) a magnetic field is set up around the coil. This interacts with the magnetic field caused by the large magnet and the coil is moved. The coil and thus the cone move in sympathy with the signal in the voice coil.

As with microphones (only more so), large loudspeakers with big cones are only capable of effectively reproducing sound in the lower end of the sound spectrum. For this reason, all high fidelity loudspeakers contain two or more 'drive' units. Each unit will be of a different size and designed to handle a particular range of audio frequencies.



A Simple Cross-over



An electronic circuit within the loudspeaker cabinet, called a crossover unit, routes the incoming signal so that the high frequency sounds are handled by the smaller unit ('tweeter') and the lower frequencies by the 'woofer'.

The crossover unit in its simplest form consists of a capacitor and an inductor. The AC impedance of the capacitor decreases as the applied signal's frequency increases. The reverse is true with the inductor.

DUAL-PURPOSE TRANSDUCERS

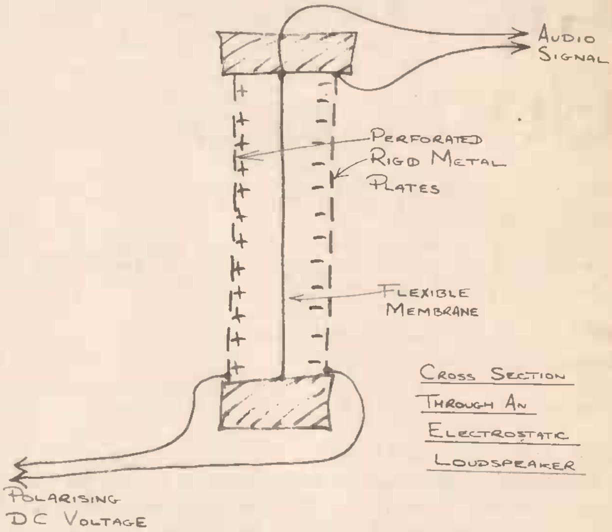
In some applications it is very convenient to use the same transducer as both a microphone and loudspeaker. An example of this is in simple intercoms. Here, a small transducer is used as a loudspeaker when listening to messages, but doubles as a microphone when messages are being sent.

A commercial electrostatic loudspeaker.

ELECTROSTATIC SPEAKERS

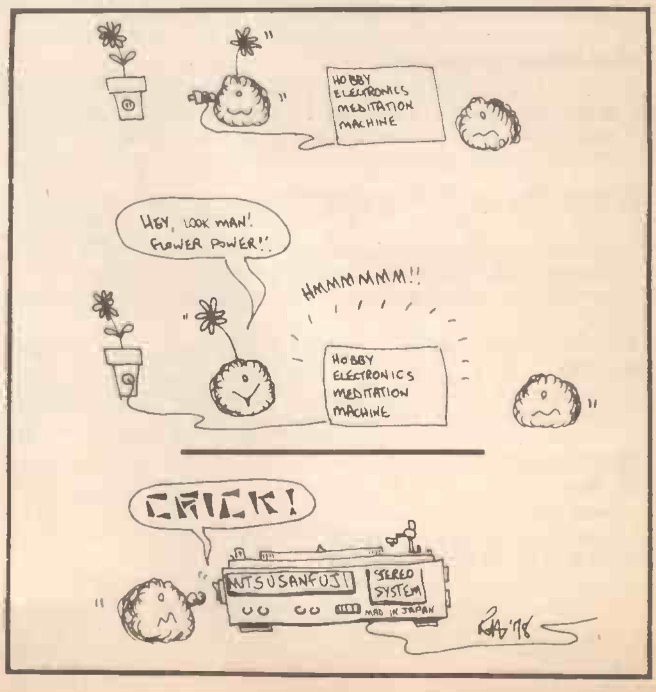
Just as there are capacitor microphones, we also have 'capacitor' or electrostatic loudspeakers. Electrostatic loudspeakers provide a very high quality sound at a very high quality price.

The cross section drawing of an electrostatic loudspeaker shows three plates. The outer two plates have charges applied to them by a high DC voltage (the polarising voltage). The audio signal (which is stepped up in voltage) is applied to the centre plate.

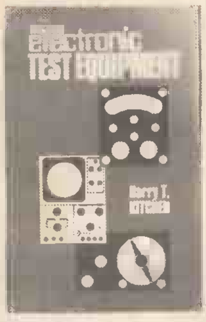


The charge on this plate will be changing with the audio signal. When there is a positive charge on the centre plate it will be attracted to the rigid negative plate, and repelled from the positively charged plate. The centre plate will vibrate, producing a sound output for the electrical input. A company in England (Quad) has been producing electrostatic speakers based on this principle for the last 20 years.

Headphones contain smaller versions of loudspeaker elements. The law regarding electrostatic headphones (300V near your ears could be quite dangerous) has recently been revised and for this reason the sale of electrostatic headphones dropped for a while. A version of electrostatic headphones which require no polarising voltage, and use instead a slab of electret material are available but do not give as good a sound as the normal (more expensive) type. **HE**



Hobby Electronics Book Service



BUILD-IT BOOK OF OPTOELECTRONIC PROJECTS by Charles Adams **£4.75**
A 48 project learn-by-building guide to the super-practical world of optoelectronics with thoroughly readable instructions on how to create everything from an LED circuit monitor to an electronic stopwatch.

HOW TO READ ELECTRONIC CIRCUIT DIAGRAMS by Bob Brown and Paul **£4.00**
This book is for the beginner who wants just enough practical knowledge of electronics to pursue a hobby.

EASY SPEAKER PROJECTS by Len Buckwalter ... **£3.75**
Explains how to make speaker systems ranging from simple shelfboard and ceiling-mounted enclosures to more advanced bass-reflex and omnidirectional ones.

ELECTRONIC GAMES AND TOYS YOU CAN BUILD by Len Buckwalter **£3.75**
A 'just-for-fun' book. No complex electronics theory anywhere — just step-by-step instructions, construction photos, and detailed wiring-construction diagrams for building 15 fascinating electronic games and toys.

MICROPHONES: HOW THEY WORK & HOW TO USE THEM by Martin Clifford **£4.75**
Takes all the mystery out of microphones, shows you how to record almost anything with professional quality, clearly explains how to get different sound effects and better stereo, and fully describes mike positioning techniques.

BASIC ELECTRONICS COURSE by Norman H. Crowhurst **£5.50**
A self-study text for the novice, hobbyist, student — a perfect reference and brush-up guide for technicians and others who want to advance their knowledge of electronics.

HOW TO TEST ALMOST EVERYTHING ELECTRONIC by Jack Darr **£3.50**
Practically every testing technique for almost every kind of electronic equipment is laid out for you in easy, highly readable style.

ELECTRONICS FOR THE AMATEUR by Louis M. Dezettel **£6.55**
Written especially for the radio amateur, discusses radio-wave propagation as it applies to amateur band frequencies, reception and transmission as they pertain to the equipment 'hams' use, and the special field of antennas and how to feed them.

ELECTRICAL SOLDERING (2nd edition) by Louis M. Dezettel **£4.45**
Teaches the hows and whys of electrical soldering. Tells about solder alloys and fluxes. Discusses the various types of soldering devices. Then concentrates on the principles of good soldering and acquiring the needed skill.

BUILD-IT BOOK OF HOME ELECTRONICS by Graf and Whalen **£3.45**
Put electronics to work for you in your home. The authors present thirteen interesting and fun projects that use the latest solid-state devices and ICs.

BUILD-IT BOOK OF SAFETY ELECTRONICS by Graf and Whalen **£3.45**
Contains ideas for building several novel projects to protect toddlers from invading the medicine chest to a motel room from a burglar; and to scare a car thief and more. Thirteen tested safety projects are detailed.

BUILD-IT BOOK OF FUN AND GAMES by Graf and Whalen **£3.75**
All the projects in this book are designed for fun and game applications. The projects include a sight'n'sound metronome, an electronic football game and stereo balance meter, a sound-activated switch and a metal detector.

IMPROVING YOUR HI-FI **£3.50**
This book is aimed at the novice who has just purchased his first audio set-up or is about to do so. It begins with details of how to connect the units together to obtain top performance and explains the meaning and proper use of the many control knobs and switches found on modern hi-fi gear.

GUIDE TO PRINTED CIRCUITS by Gordon J. King . **£3.50**
The Text is angled especially at the keen amateur constructor, the experimenter, the service technician and apprentice.

ELECTRONIC TEST EQUIPMENT by Harry T. Kitchen **£5.00**
This book is designed to provide interest for almost everyone involved with electronics. The six chapters explore the more general groups of instruments such as test meters of various types, audio and r.f. signal generators, attenuators and oscilloscopes. Each chapter explains the principles and requirements of particular types of test equipment, including typical circuitry, then discusses the choice, care and use of the equipment.

FUN WITH ELECTRONICS by McEntee **£3.40**
An exciting show-tell-and-build-it book that teaches electronics with plenty of fun in the process.

AUDIO AMPLIFIERS FOR THE HOME CONSTRUCTOR by Ian Sinclair **£2.60**
Describes in seven chapters the working principles of transistor amplifiers and outlines the steps and circuit design using a modern simplified transistor theory.

INTRODUCING ELECTRONIC SYSTEMS by Ian Sinclair **£1.80**
This book by author-lecturer Ian Sinclair is intended to provide a basic insight into what makes electronics 'tick'.

INTRODUCING AMATEUR ELECTRONICS by Ian Sinclair **£1.55**
This is the book for the complete novice of any age, in which author Ian Sinclair assumes no previous knowledge of the subject by the reader.

ELECTRONICS FOR THE BEGINNER (2nd edition) by J. A. Stanley **£4.15**
A learn-by-doing approach to electronics. Each project is of increasing difficulty, so the beginner also picks up a liberal dose of electronics theory along the way.

ABC'S OF FET'S by Rufus P. Turner **£3.05**
Describes the field effect transistor (FET) in simple language. Deals in detail with the principles of FET operation and stresses the applications of FETs in practical circuits.

ABC'S OF ELECTRONICS (2nd edition) by Farl J. Waters **£4.15**
An introduction to the ever-expanding field of electronics. Covers the principles of electricity, functions of atoms and electrons, magnetic forces and their relationship to electronics.

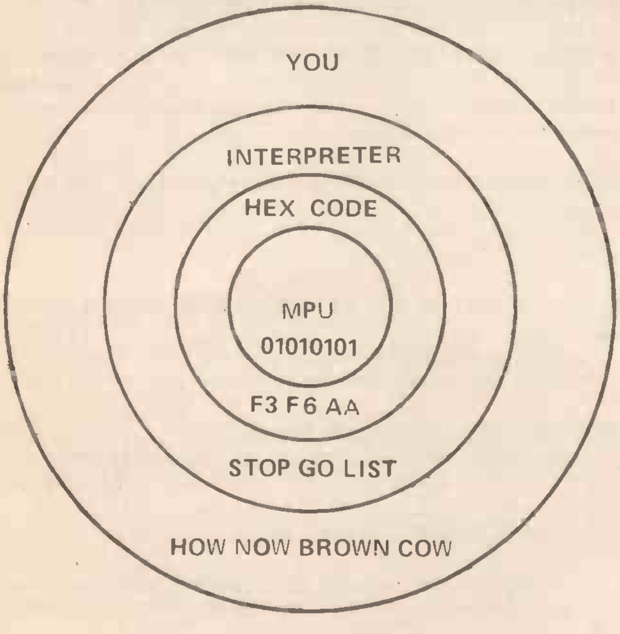
Note that all prices include postage and packing. Please make cheques, etc. payable to Hobby Electronics Book Service (in sterling only please) and send to:

Hobby Electronics Book Service,
P.O. Box 79,
Maidenhead, Berks.

Home Computers

VDU's, MPU's, UART's, EPROM's and floppy disks are just some of the seemingly incomprehensible bits of jargon used in the world of computers. With the availability of cheaper units the small computing system has started appearing in more and more places — with hundreds being sold every month for use in the home. What are they, how do they work and what's the point? Jim Perry explains . . .

UNTIL RECENTLY EVERYONE knew what a computer was — a huge machine that cost hundreds of thousands of pounds, used to print driving licences and send out electricity bills for £00.00p. Also, the people who operated them were University graduates with PhDs in mathematics or computer science. Well, all that has changed, certainly the huge machines are still around, but the fastest growing market is in very small computer systems — within the reach of virtually everybody. In fact you can buy a computer for less than you would spend on a second-hand car!



The various levels between you (the real world) and the binary intelligence of a computer system. Most computers for use in the home have an interprefer level, although some are only useable with lower level 'machine code.'

IN THE BEGINNING

In 1970 the Intel Corporation developed a computer in a single package called the 4004. It was not anywhere near as powerful as conventional computers, and was only the central part of the computer. They called it a microprocessor (the processor being the central part of any computer and micro meaning small). In order to do anything with it you needed some memory (so that it could store results of calculations and instructions — usually in a special memory called read only memory or ROM), plus some way to enable the machine to make contact with the user (interface with the real world).

Manufacturers soon realised that they could make more and more powerful computers easily and cheaply — and promptly did so. Modern computers are based on any of several competing devices. Needless to say virtually none of the different computer chips behave in the same way — and each manufacturer claims that their devices are the best!

Luckily the differences in the way each brand works internally does not really affect the end user, if the system is purchased prebuilt. For most purposes the actual micro-processor unit (MPU) can be regarded as a 'black box', the reason being that all of its idiosyncracies are hidden behind an 'interpreter' within the system.

Within each computer there are several levels of intelligence — the more intelligent the section, the slower it is; the more stupid, the faster! In fact, at the heart of the machine is the most stupid (but very fast) part — the MPU itself — which only converses in gutteral grunts with the rest of the system (in real terms either high or low voltage levels). The slowest part is the interpreter, which allows you to give instructions in a more useful and understandable form — called a high-level language.

Computer languages also come in different shapes and sizes (just like the abundance of MPUs) but the most popular in small systems is called BASIC (short for Beginners All purpose Symbolic Instruction Code). In BASIC, if you type in the instruction LIST the interpreter will slowly translate this into a series of high and low voltage levels which the MPU will realise means "Oh, my master wishes me to display all the instructions he has given me" and do just that. Of course when we say slowly it is only relatively slow, it might take the exceptionally long time of a second to display the result of your instruction!

The interpreter that allows you to communicate in BASIC is in fact a computer program that has been specially written in another language called 'machine code', which is the only language the MPU understands. Machine code is a series of binary words (each word is a byte, each part of a byte is called a bit and is either high or low). The word length is always fixed and in most small computers it is eight bits long.

Because the word length is fixed, you know exactly how many wires are needed to interconnect the parts of the system. This is done using a thing called a data bus. The bus is not of the omni type, but is a set of wires connecting all the various parts together. Usually you need 24 wires for the memory connection, a couple for power and usually a couple more for various other functions and all the memory devices and input/output devices are connected to this common set of wires.

Because everything is wired to the same data bus, the MPU can talk or listen to lots of different sections very easily and quickly — but it can only do one thing at a time (usually).

Above can be seen the Hobby Electronics pet PET! We use our computer for administration budgeting, games and calculation plus many other things — in the photograph our administration lady Margret is checking the editorial budget. At the bottom of the page is the Bywood Electronics computer system. Called Scrumpi 3, the system is based on a SC/MP device. Although used by amateurs it is really designed for use in industry, as a dedicated control system or semi-intelligent terminal.

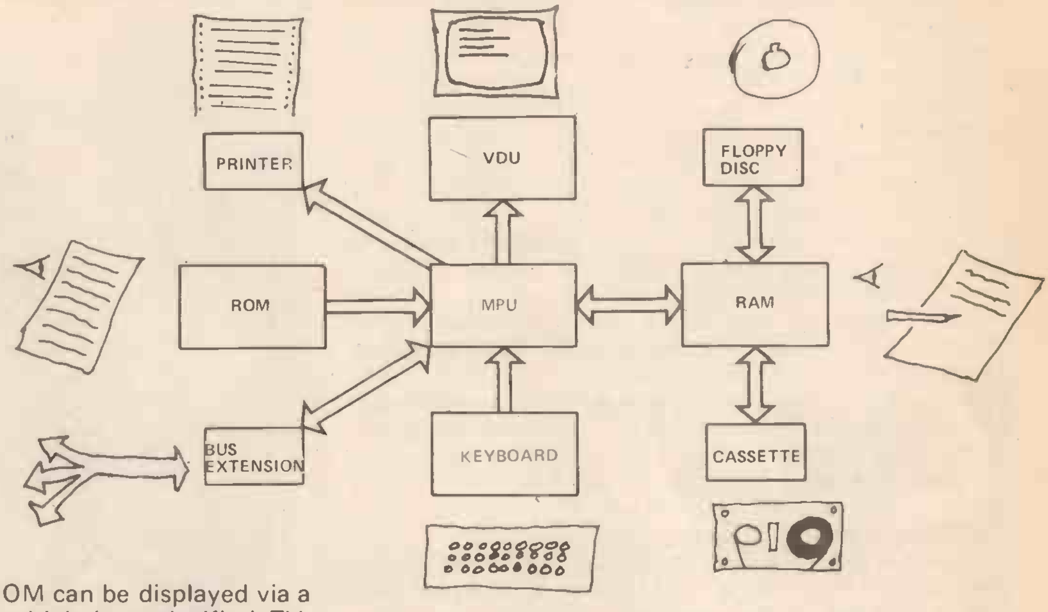
SUGAR AND SPICE

. . . and all things nice, are not what little computers are made from! Let's look at what a small computer system *could* have and what all the bits are for.

The MPU handles all the adding up, subtraction and jumping around with binary words (bytes). Connected to the MPU is some Read And write Memory (RAM), which it uses for storing results of calculations and anything too big to fit inside the MPU itself. If the machine is an 8-bit type, the RAM will be arranged as 8 wide by up to 64 thousand deep. This top limit is in fact a function of the word length — any larger and the MPU would not be able to cope with all the various 'addresses' of data stored in the memory. Usually, small systems have 8K of RAM (K is short for the computer 1000 — which is really 2^{10} or 1024!). The interpreter will either be stored in ROM or loaded into RAM from a cassette tape or magnetic disk.

BASIC interpreters can occupy as little as 2K of memory (TINY BASIC) or as much as 12K (Extended BASIC). Obviously, the more K occupied, the more powerful the version. If you have to load the interpreter into RAM there will be a small amount of RAM used for a mini-interpreter called a monitor, which can cope with telling the MPU how to load the interpreter proper from outside.

All the inter connected parts of a complete computer system for the home. Systems will work without floppy disk or printer but they are very useful, and are usually added as soon as they can be afforded. Extra memory can also be added as required, to the BUS.



The contents of RAM or ROM can be displayed via a Video Display Unit (VDU) which is a glorified TV, complete with special devices called character generators to produce the various letters and figures on the screen. As well as the VDU, you can have the option of a 'hard copy' print out: a typewriter controlled by the computer. Input to the system is usually through a typewriter keyboard, the output from which is converted to a special code called ASCII (American Standard Code for Information Interchange) which the interpreter can understand. Other inputs can be made from magnetic tape (cassettes usually), magnetic disks (called floppy disks, because they are floppy!) and sometimes paper tape.

The cassette or disk can both be used to store information from the system. Cassettes are very slow, but cheap — disks are very fast, but expensive, so you pays your money and takes your choice. The fastest memory is RAM, but it is the most expensive — and also all the information in it disappears when the power is turned off, unlike ROM, cassettes or disks which retain information without power.

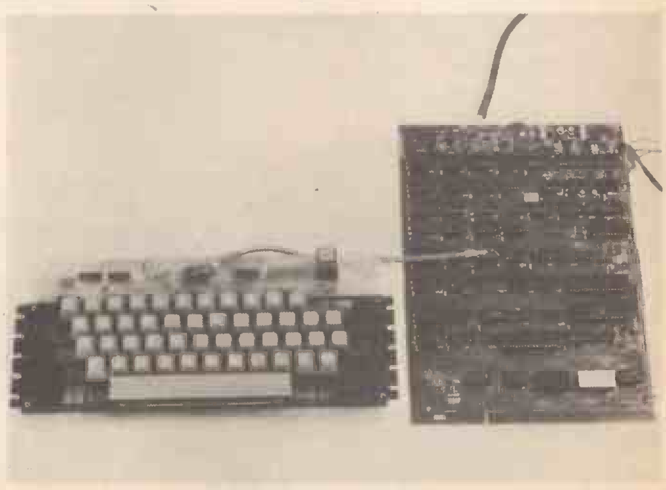
So what do we use a small computer for and how much will it cost? The first part is easy to answer — anything you want to do (within reason) can be done with a small system in the home. The second answer is between £200 to £2000 depending on the bits and pieces you want (floppy disks and printers are expensive).

To go back to the first question, it probably sounds flippant and not informative to say you can do anything — but you can! The first step is to learn the language — which is far easier than learning a foreign language — after all, BASIC is nearly English! Second step is to literally play with the system and explore the possibilities.

In fact, the best way to learn to program (or talk in BASIC) is to actually try it. Most people practice with games — Star Trek and Moonlander being two of the most famous. In a lot of ways the home computer starts off as an addictive hobby and develops into a useful tool — used for no end of applications, ranging from computer music to central heating control.

So computers are not fiendishly complex devices that cost hundreds of thousands, they are cunningly complex devices that are easy to use and cost very little — and the applications are endless. Happy computing! **HE**

South West Technical Products system is based on the 6800 computer. Available as a kit or ready built, the system comes with 4K or memory. Keyboard, cassette and all other extras are available at extra cost, either as kits or ready built. Interpreters are available in several formats.



A photo of the Lynx 'NASCOM 1' system. This uses the 8080 processor's 'big brother': the Z-80. The Z-80 will handle programs written for itself (naturally enough) and for the 8080. This makes it a very useful device.

Home Computers

Commodores PET is a display, cassette, keyboard and computer all in a single cabinet. Based on a 6502 computer, the system has a built-in BASIC — stored in ROM. Standard memory is 8K plus 4K monitor system. PET is only supplied prebuilt.

Our sister magazine, Electronics Today International, have just published the design for this computer — called the TRITON. While the actual construction is rather complicated, once constructed it is as easy to use as any BASIC computer.

ASSEMBLER: Software which converts assembly language statements into machine code and checks for non-valid statements or incomplete definitions.

BINARY: The base two number system. The digits are 0 to 1. They are used inside a computer to represent the two states of an electric circuit.

BIT: A single binary digit.

BUG: A program error that causes the program to malfunction.

BUS: The interconnections in a system that carry parallel binary data. Several bus users are connected to the bus, but generally only one "sender" and one "receiver" are active at any one instant.

BYTE: A group of bits—the most common byte size is eight bits.

COMPILER: Software which converts high level language statements into either assembly language statements, or into machine code.

CPU: Central processor unit. The part of a system which performs calculation and data manipulation functions.

CUTS: Computer Users Tape System. Definition of system for storing data on cassette tape as series of tones to represent binary 1's and 0's.

DEBUG: The process of removing bugs.

EPROM: Electrically Programmable Read Only Memory. Memory that may be erased (usually by ultra violet light) and reprogrammed electrically.

FIRMWARE: Instructions or data permanently stored in ROM.

FLOPPY DISK: Mass storage which makes use of flexible disks made of a material similar to magnetic tape.

FLOW CHART: A diagram representing the logic of a computer program.

HARD COPY: System output that is printed on paper.

HARDWARE: All the electronic and mechanical components making up a system.

HEXADECIMAL: The base 16 number system. Character set is decimal 0 to 9 and letters A to F.

INTERFACE: Circuit which connects different parts of system together and performs any processing of signals in order to make transfer possible (i.e. serial-parallel conversion).

INTERPRETER: An interpreter is a software routine which accepts and, executes a high level language program, but unlike a compiler does not produce intermediate machine code listing but converts each instruction as received.

I/O: Input/Output.

KANSAS CITY (Format): Definition of a CUTS based cassette interface system.

LANGUAGE: A systematic means of communicating with an MPU.

PERIPHERAL: Equipment for inputting to or outputting from the system (e.g. teletype, VDU, etc).

PORT: A terminal which the MPU uses to communicate with the outside world.

PROGRAMS: Set of MPU instructions which instruct the MPU to carry out a particular task.

PROM: Programmable read only memory. Proms are special form of ROM, which can be individually programmed by user.

RAM: Random Access Memory. Read write memory. Data may be written to or read from any location in this type of memory.

ROM: Read Only Memory. Memory device which has its data content established as part of manufacture and cannot be changed.

SOFTWARE: Programs stored on any media.

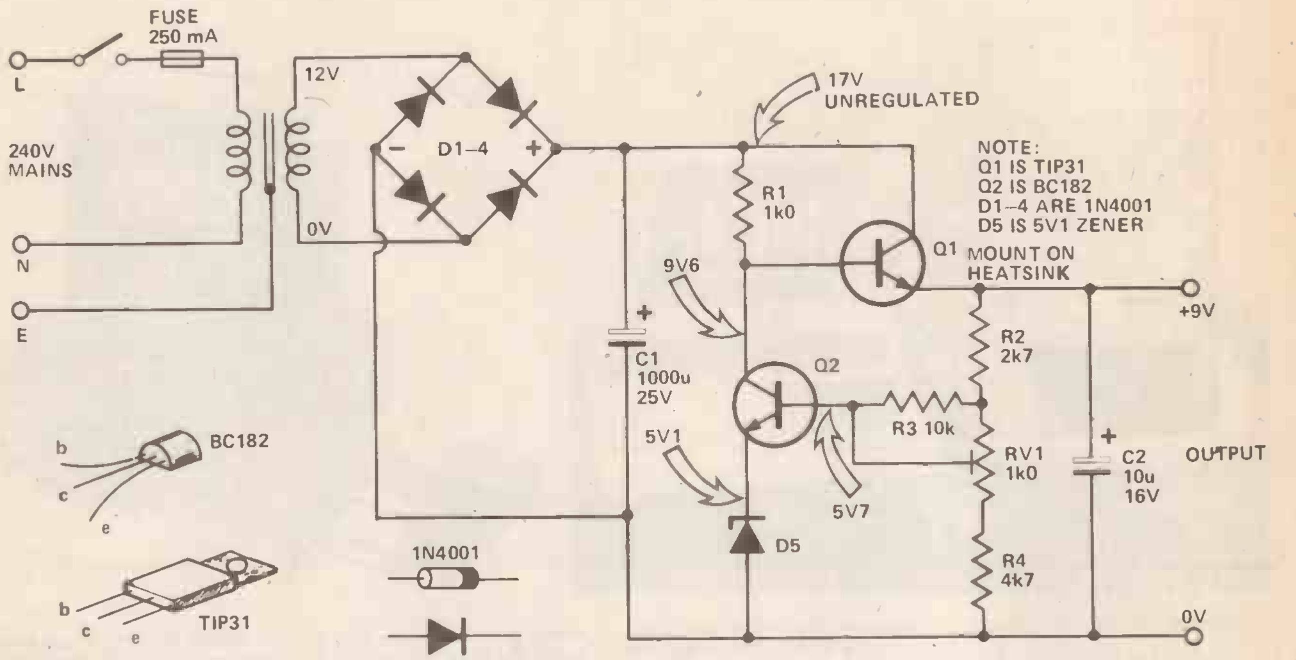
SUBROUTINE: A sequence of instructions which perform an often required function, which can be called from any point in the main program.

SYNTAX: The grammar of a programming language.

VOLATILE: Memory devices that will lose data content if power supply removed (i.e. RAM).

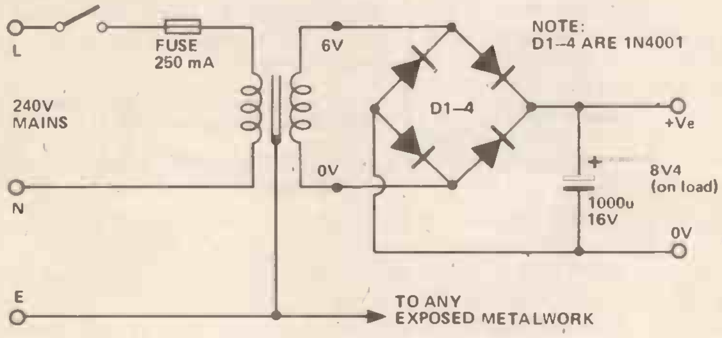
Short Circuits

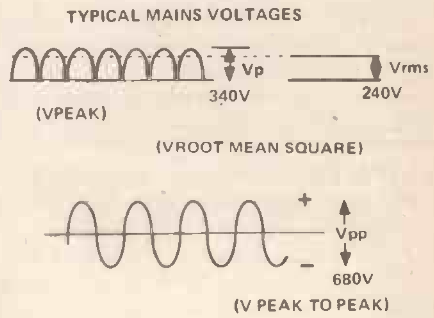
POWER SUPPLY WITH TRANSISTOR REGULATION



Two transistors and a voltage reference can be used to make a regulated power supply. Transistor Q1 is used as the power control element and so must be mounted on a heat sink. Q2 provides negative feedback and so helps to iron out any changes at the output due to fluctuating load conditions or variations in the unregulated rail. The circuit operation is as follows. A current flows through Q2 and D5 and so sets up a voltage of 5V1 across D5. The base of Q2 is connected to the output by a set of resistors, R2, 3, 4 and RV1. If the output voltage rises, then more current will flow through Q2. This causes the voltage at the base of Q1 to fall, which in turn reduces the voltage at the output. Thus the output voltage is regulated. RV1 is used to set up the output voltage to +9V. If the wiper of RV1 should accidentally lift off, then the output voltage would instantly rise to that of the unregulated rail. To prevent this R3 provides a permanent DC path to the base of Q2. Capacitor C2 helps to improve the regulation when the load conditions change rapidly.

UNREGULATED POWER SUPPLY





A single rail power supply is shown in the diagram above. It has three separate sections, the mains transformer, the full wave bridge rectifier and the smoothing capacitor. For safety, the fuse is put in the live wire path to the transformer. Also the live is connected to the 240V terminal of the transformer. This part of the primary winding is furthest away from the secondary, and so increases the safety of the unit. The earth should be connected to any exposed metalwork in the power supply and to the transformer screen if it has one. The voltages quoted are AC voltages measured in Volts RMS. This is the equivalent "DC heating" voltage and is equal to 0.707 x Vp.

The output of the transformer is 6V RMS and this is the voltage level "on load". When the transformer is not loaded this voltage may increase by about 25%.

The difference between the loaded and unloaded output voltage is known as the "regulation" of the transformer. Transformers have power ratings expressed in terms of VA. A 10VA transformer will be able to supply 10 watts of power from its secondary output. The AC voltage from the transformer secondary is full wave rectified by the diode bridge D1 to 4 and then smoothed by capacitor C1. With no load on the power supply the output (DC) voltage will be approximately 11V. But when a resistive load is presented to it, the voltage drops and a ripple voltage appears, this being caused by the load discharing the capacitor.

RIPPLE RULE OF THUMB:

$$V_{rip} \simeq \frac{I_{load}}{C} \times (7 \times 10^{-3})$$

SO IF THE LOAD CURRENT (I load) IS 100mA,
THEN Vrip IS $\frac{0.1 \times 7 \times 10^{-3}}{10^{-3}} = 700\text{mV}$

SPECIALS

£2.50 + 25p P&P

ETI top projects 1 + 2 include:
Master mixer, 100 W guitar amp., low power laser, printmeter, transistor tester, mixer preamp, logic probe.

£1.00 + 25p P&P

Ni-Cad charger, loudhaller, 'scope calibrator, electronic ignition, car theft alarm, turnindicator canceller, brake light warning, LM380 circuits, temperature alarm, aerial matcher, UHF TV preamp, metal locator, four-input mixer, IC power supply, rumble filter, IC tester, ignition timing light, 50 W stereo amp. plus many more. . . .

ETI Top Projects 3. This issue was so popular that it is now sold out!

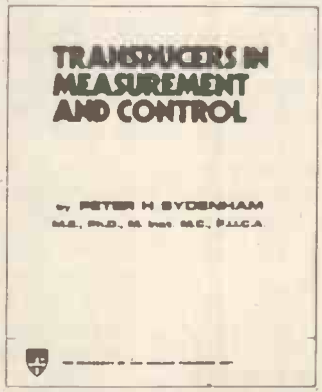
ETI Top Projects 4 includes:
Sweet sixteen stereo amp., waa-waa, audio level meter, expander/compressor, car theft alarm, headlight reminder, dual-tracking power supply, audio millivoltmeter, temperature meter, intruder alarm, touch switch, push-button dimmer, exposure meter, photo timer, electronic dice, high-power beacon, electronic one-armed bandit! . . .

ETI Top Projects 5. Twenty-two complete projects, including:
5 W stereo amp., stage mixer, disco mixer, touch organ, audio limiter, infra-red intruder alarm, model train controller, reaction tester, headphone radio, STD timer, double dice, gen.-purpose power supply, logic tester, power meter, digital voltmeter, universal timer, breakdown beacon, heart rate monitor, IB metal locator, temperature meter. . . .

ETI Top Projects 6, just published, includes:
Graphic equaliser, 50-100 W amp. modules, active crossover, flash trigger, "star and dot" game, burglar alarm, pink noise generator, sweep oscillator, marker generator, audio-visual metronime, LED dice, skeet game, lie detector, disco light show. . . .

75p + 25p P&P

Comprised entirely of new material, the edition covers such diverse subjects as Star Wars and hi-fi! The magazine contains projects for everyone — none of which have appeared in ETI or Hobby Electronics and a look at the future of MPUs, Audio, Calculators and Video. How can you not read it?



£3.00 + 25p P&P

This book is rather an unusual reprint from the pages of ETI. The series appeared a couple of years ago in the magazine, and was so highly thought of by the University of New England that they have re-published the series splendidly for use as a standard textbook. Written by Peter Sydenham, M.E., Ph.D., M.Inst.M.C., F.I.I.C.A., this publication covers practically every type of transducer and deals with equipment and techniques not covered in any other book. Enquiries from educational authorities, universities and colleges for bulk supply of this publication are welcomed. These should be addressed to H. W. Moorshead Editor, Hobby Electronics.

Each volume contains over 150 circuits, mainly drawn from the best of our Tech-Tips. The circuits are indexed for rapid selection and an additional section is included which gives transistor specs. and plenty of other useful data.
Sales of this publication have been phenomenal — hardly surprising when the circuits cost under 1p each! Each volume costs:

£1.50 + 25p P&P

ETI's successful beginners series came to an end some time ago now, and the whole series is available from us in reprint form. The three books between them contain all the information presented in the series (sometimes in more detail!) and together form an excellent starting point for anyone interested in learning the art of electronics. Each volume costs

£1.20 + 25p P&P

HOW TO ORDER

Postage and packing also refers to overseas. Send remittance in sterling only.

Specials
Modmags Ltd
25-27 Oxford Street
London W1R 1RF

Please mark the back of your cheque or PO with your name and address.

Please supply me with the following Specials:

. . . .

. . . .

. . . .

. . . .

. . . .

Total cheque/PO enclosed = £ . .

Address:

M . . . .

. . . .

. . . .

. . . .

Metal Locators

Every weekend tens of thousands of treasure hunters take to the countryside with their metal locators. Originally, ex-Army mine detectors were used but current models use highly sophisticated electronic techniques.

DURING WORLD WAR II extensive use was made of anti-personnel mines — minefields were laid for endless miles along most fronts and were very effective in holding up advancing armies. It was the job of the Sappers to clear paths through these fields and considerable skill was shown by scientists in designing electronic equipment for them to find the mines. After the war these mine detectors appeared on the surplus market and people soon found that you could find all sorts of metal with them — this was the start of the metal locating craze that is now in full swing in North America and Britain. Ex-Army metal locators had been designed for a specific purpose and soon proved to be poor at finding small metal objects. About 10-15 years ago a number of companies set about designing machines specifically for the amateur treasure hunter.

DO THEY WORK?

The immediate reaction of many people when they first come across metal locators is to doubt their effectiveness — it is not the electronic performance they question as much as the 'density' of objects worth finding. However, just ask yourself how many coins you lose each year: many will be found by someone else but the vast majority of us are sowing the seeds to excite future treasure hunters. If you are still not convinced, dig up a couple of square feet of your garden to a depth of 150 mm and search through it — you'll be amazed at the number of man-made objects you'll find.

Although in the past there were fewer people with far less money, there were no banks; when plundering armies were on the march the best you could do was to bury your goodies in the ground, ploughs turn up a lot but most are usually filthy and are not easily seen even from a few centimetres — but a metal locator will not be fooled.

ELECTRONIC TECHNIQUES—

There are a number of techniques that are used but two of them are currently dominant with manufacturers — BFO (Beat Frequency Oscillator) and IB (Induction Balance). Both make use of coils of wire which are wound inside a 'search head' which is then panned across the surface of the ground.

The BFO machines use a single coil which forms an inductance and which is part of an oscillator — the type of oscillator circuit is not very important but it should be stable. The frequencies used vary a lot; in Britain regulations allow a maximum frequency of 150 kHz and most machines operate in the 50-130 kHz range. This part of the circuit is largely independent of the remainder though it normally shares the same battery supply.

The frequency at which the oscillator works is dependent on the values of the capacitance and inductance in the circuit. (The formula is $f = 1/2\pi\sqrt{LC}$ where f is the frequency in Hertz, L is inductance in Henries and C is Capacitance in Farads.)

When you bring metal near the coil you alter the inductance slightly and, as the formula shows, the frequency is dependent upon inductance and the frequency will change. The frequency change is also dependent on the size of metal and its distance from the coil. Clearly the smaller and further away the metal, the smaller the effect on the inductance and consequently the smaller the frequency change.

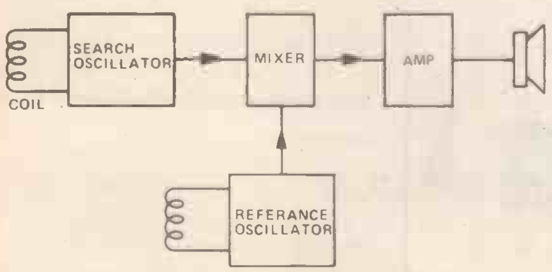


Fig. 1. Block diagram of a typical BFO metal locator. It is the coil in the search oscillator that is panned over the ground. The second coil, associated with the reference oscillator, is in with the majority of the components.

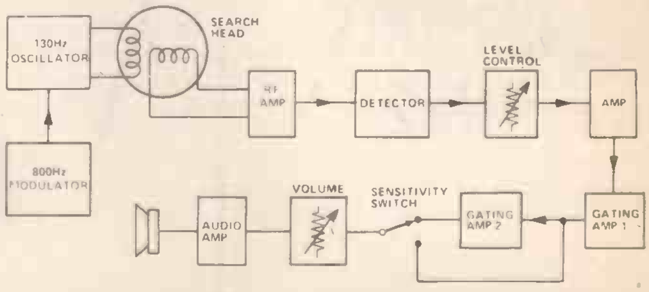


Fig. 2. Block diagram of an IB metal locator. Techniques vary from machine to machine but the principle is the same. This diagram is of the IB Metal Locator Mk 1 from our sister magazine Electronics Today International.

Almost more important than the electronics in a metal locator is knowing where to search; old sites are obviously the best.

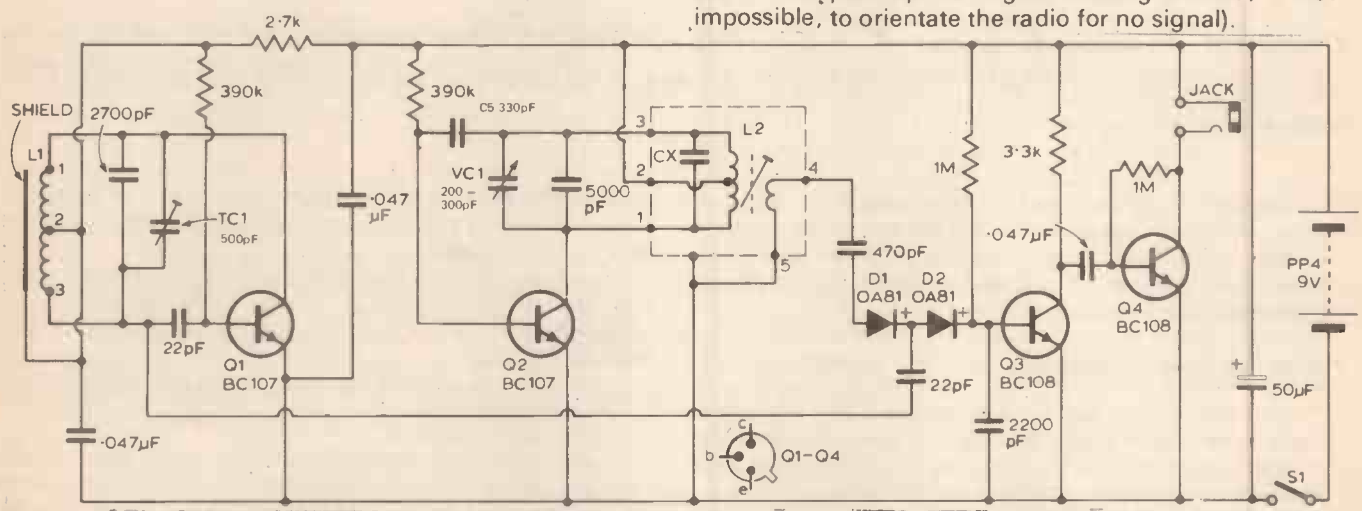


Fig. 3. Complete circuit of a BFO metal locator. A complete description of this appears in ETI Top Projects 1&2. Q1 and the surrounding components form the search oscillator. L1 is made from 50 turns of 26 s.w.g. on a 130 mm former, centre tapped.

The reference oscillator is Q2 with L2 which is a Denco IFT 13. The mixing function is carried out by D1 and D2 while Q3 and Q4 are the amplifier. Headphones are inserted into the jack to hear the signal.

What the rest of the electronics does is to convert that frequency change into something you can hear (or see). The BFO technique uses another oscillator with quite separate capacitance and inductance but operating on virtually the same frequency as the oscillator associated with the search coil. The outputs of both these oscillators are mixed together to produce a different signal — thus if one is on 100.0 kHz and the other in 100.5 kHz you have a difference of 500 Hz — this can then be amplified and fed to a speaker. If the change in inductance brought about by metal near the coil causes the 100.0 kHz to become 99.9 kHz (a 0.1% change), the audio frequency will change from 500 to 600 Hz — a change of 20%.

In practice the two oscillators are usually set to produce a very low note — say 50 Hz — and as you will still get a 100 Hz change the difference would be 300%! Our ears are very sensitive to changes in frequency so really minute changes in the inductance of the search coil can be heard.

The IB principle is quite different. There is a coil which forms part of an oscillator — working on roughly the same frequencies — but normally this is modulated: that is, an audio tone is superimposed on it; this is simple to do electronically.

There is a second coil in the search head which is arranged so that it overlaps part of the first coil. If you lay your coils out perfectly there will be no (practically no) signal transferred from one to the other, despite their proximity. This is because the electromagnetic fields cancel out in the second coil. However, when metal is brough near this arrangement, the electromagnetic field is distorted and there is no longer cancellation; the signal induced into the second coil is then picked up, the audio tone is extracted and amplified. Instead of a frequency change as with BFO types, there is a volume change when metal is near the search head.

You can demonstrate the basic technique easily using a portable radio.

Tune this to a fairly weak station and orientate the receiver so that no signal is received. If you then move this near to a large metal object, say a car or a vertical water pipe, but keeping the same orientation, the signal will return. Here the large metal object is distorting the signal field of the radio station (powerful radio stations won't work, as odd wires — even transistor leads in the set — will pick up the signal making it hard, if not impossible, to orientate the radio for no signal).

FARADAY SHIELDS

With both types of metal locator the effect of the ground can upset the search for metal. Bringing the search head near the ground will cause additional capacitance to be added to the tuned circuit and this of course is undesirable. This can be reduced dramatically by using a Faraday shield between the coil and the ground. These take a number of forms but in BFO types the coil is often wrapped in foil which is 'earthed' (normally to battery negative). With IB types this doesn't work due to the different techniques but a wire mesh will work, though this has to be arranged so that it does not itself form a coil.

DIY DESIGNS

Our sister magazine, Electronics Today International, has described projects for both types of metal locator. ETI Top Projects 1 + 2 has a BFO design and Top Projects No. 5 gives details of an IB metal locator. We are not saying they are easy to build — they are not — but they make interesting reading. HE

The Strange Case of Cygnus X-1

Circinus X-1, or Cygnus X-1 as it is called in this country, is a very very strange star indeed — perhaps even a neutron star? We examine the possibility . . .

THE ENIGMATIC BEHAVIOUR of Circinus X-1, the first cosmic X-ray source to be found in the constellation Circinus, 30 000 light years distant, has defied explanation since it was first detected by satellite-borne X-ray telescopes in 1971-72.

Dr Raymond Haynes, an astronomer with CSIRO's Division of Radiophysics who, with four colleagues, Drs Ian Lerche, David Launcey, Jim Caswell and Paul Murdin, has proposed an explanation for the odd behaviour of Circinus X-1, says it has been found to be not one object but two — a tiny, incredibly dense neutron star in elliptical orbit around a massive supergiant sun.

Approximately every 16 days, after travelling 320 million kilometres, the neutron star hurtles across the face of the supergiant. Tidal forces exerted by the neutron star pull a million billion tonnes of hot, gaseous matter off the supergiant at each pass.

The fiery tide rains down onto the surface of the neutron star, creating a massive three-day outburst of radiation which is detectable by radio and optical telescopes in the southern hemisphere.

CO-OPERATIVE EFFORT

Circinus X-1 yielded its secrets only after collation of an enormous amount of data from combined observations made with CSIRO's 64-metre Parkes radiotelescope, NASA's 64-metre radiotelescope at Tidbinbilla, Sydney University's Fleurs synthesis and Molonglo radiotelescopes, the Anglo-Australian Observatory's 4-metre optical telescope and the UK Schmidt optical telescope.

Dr Haynes said the co-operative work provided the clues necessary to a detailed understanding of the strange behaviour of Circinus X-1.

Every 16 days and 14 hours, the X-rays are cut off and radio flares are detected at intervals of about 18 hours. The increase in brightness is due to a swelling of the supergiant's size as the tidal attraction of the neutron star grows stronger.

The first radio measurements of a point source near the position of Circinus X-1 were obtained by CSIRO researchers in 1974-75, using the Parkes and Molonglo radiotelescopes.

About the same time, an Observatory team discovered a massive supergiant with an extremely red spectrum near the same position.

Evidence linking the radio source, X-ray source and visible supergiant was obtained.

Then CSIRO scientists discovered the radio source flared up in intensity every 16 days, shortly after the X-ray source turned off.

Recent radio observations by CSIRO researchers using the Parkes and Tidbinbilla radiotelescopes and the Fleurs synthesis radiotelescope defined the pattern of radio flaring at different frequencies, allowing them to deduce how the radio waves are generated.

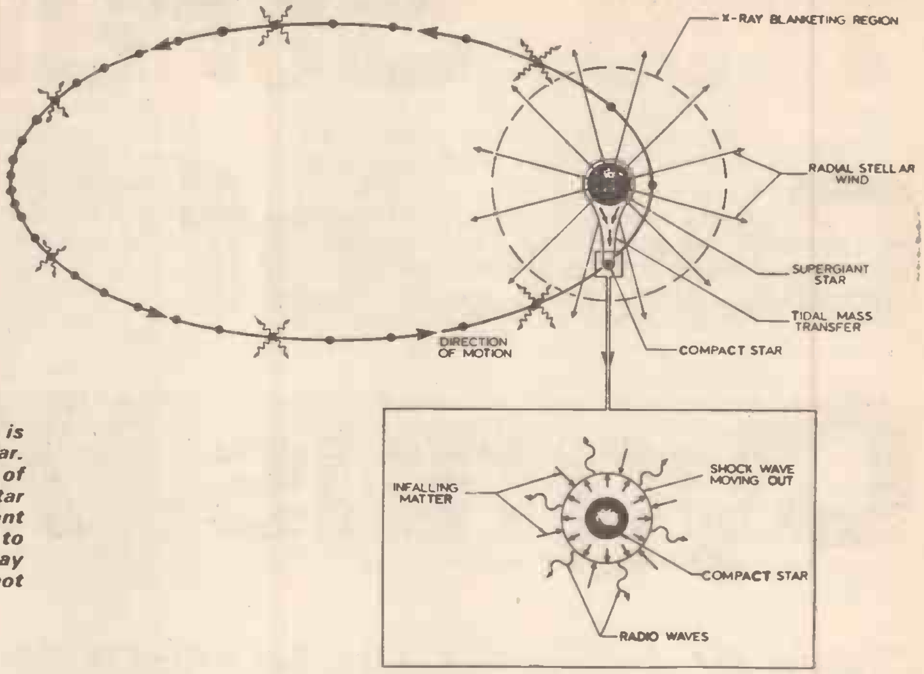
Dr Haynes says that during the neutron star's close encounter with the supergiant, the supergiant's stellar wind completely blankets the neutron star's characteristic X-ray emissions.

Only after the compact star has moved away from its supergiant companion does the blanketing effect thin out enough to allow the X-rays to "shine" through and to be detected by X-ray satellites.

BLACK HOLE?

Although the evidence strongly suggests that the smaller object is a neutron star, Dr Haynes says there is a possibility that it may be one of the elusive "black holes" predicted by cosmologists.

Such theories predict any star larger than 10 solar masses will undergo complete collapse under its own



The cycle of events. The neutron star is shown in orbit around the supergiant star. The dots represent equal time intervals of approximately half a day. The compact star accelerates as it approaches the supergiant and swings around it, taking 16.6 days to complete the cycle. It is inside the X-ray blanketing region for about three days (not to scale).

gravity, so that all matter is crushed to a single point, a "singularity" from which nothing, including light, can escape — a "black hole".

Stars with a mass less than 10 times that of our own sun will eventually collapse under their own gravity into tiny, incredibly dense objects only a few kilometres across in which the spaces within and between atoms no longer exist — neutron stars.

NO!

Dr Haynes said astrophysicists were excited by the discovery because their co-operative efforts had not only forced Circinus X-1 to reveal how it "ticks", but had also allowed its future behaviour patterns to be predicted.

Two of these predictions had already been verified, adding to the evidence of the supergiant-neutron star pairing.

HE

Advertiser's Index

Jargon

GOD CAST TO TYPE —DE LAWD NEVER WAS REPEAT ROLE — is a headline from the American magazine "Variety". If you don't know the language of show business the chances are you will not be able to make head nor tail of it — at best you might totally misinterpret it. Jargon is the shorthand of every profession — but each profession has its own. Electronics is probably one of the worst culprits, partly because everything is developing so fast you need to use a mental and verbal shorthand to remember everything. Most of the jargon in electronics is the use of initial letters as words, and abbreviation of common terms and names.

Some abbreviations are common to lots of different areas; for example, different manufacturers use different prefix numbers or letters for the same devices — as a result a NE555 will be referred to simply as a "555". Similarly, general purpose op-amps (whoops, operational amplifiers) are made from CA, LM, DM and uA prefix letters, but they are all basically the same, so a LM741 is just a 741.

An exception to the number-only game is with suffix letters; these usually signify package type or selected characteristics (such as operating voltage or temperature range). Common suffix letters are CP, which stand for commercial grade (C) and plastic package (P), but different manufacturers use different codes. So unless a special device is needed, we mean CP (cos it's the cheapest usually!).

"CMOS" is a word made from "Complementary Metal Oxide Semiconductor", which is a rather large mouthful. Two types of CMOS are generally available "A" series and "B" series, in general use B series as it is protected against static discharge which can destroy it. "A" series is sometimes needed, but usually only when the circuit operates CMOS in the "linear mode", whereas it is meant to operate as a digital switching device.

Some of the more common deviations from Queen's English are listed for your edification. By the way, I never did find our what "Variety" meant! **HE**

AMP — Short for amplifier, a circuit which is used to make electrical voltages larger.

BASE — One of the three connections on a transistor. Changing the current flowing into the base by a small amount changes the current flowing between the other two connections by a larger amount.

BIAS — This is a term used to describe the addition of a constant voltage to a signal.

CMOS — Complementary Metal Oxide Semiconductor, a type of structure used in integrated circuits which consumes very little power.

COUPLE — Connecting one block in a circuit to another.

DECOUPLE — 'Decoupling' is used so that part of a circuit which draws a high current does not affect another part of the circuit connected to the same power source.

DMM — Digital Multimeter, a device for measuring voltage, current and resistance which displays values on a digital display rather than on a meter with a pointer and scale.

DVM — Digital volt meter.

EDGE — The 'step' between two different voltage levels.

EQUALISATION — Alteration of a circuit's characteristics to produce a specific response.

FET — Field Effect Transistor, special device which has a 'source' and two 'drains' rather than emitter, collector and base.

HARMONIC — A whole number multiple of a particular frequency.

IC — Integrated Circuit. A circuit consisting of many components (possibly several thousand) which is made on a small piece of silicon about ¼" square.

IMPEDANCE — A measure of the amount a circuit or component opposes the flow of an alternating current through it.

LCD — Liquid Crystal Display. A type of display in which a very thin film of special liquid is sandwiched between two glass plates. The display is normally clear but when a voltage is applied to electrodes on the glass, the liquid becomes opaque around the electrode.

LDR — A light-dependant resistor.

LED — A Light Emitting Diode is a device which only allows current to pass in one direction and when current is flowing through it emits light of a specific colour depending on the material from which it is made.

LSI — Large Scale Integration. An abbreviation used to describe the manufacturing of a circuit (consisting of many thousands of components) on a small piece of silicon about ¼" square.

MPU — Micro-Processor Unit. The device which forms the basis of all small computer systems.

NI-CAD — A type of battery (using NIckel and CADmium) which is rechargeable.

NOISE — Anything 'unwanted' which appears with a signal.

NPN — A particular structure of transistor (Negative Positive Negative).

PCB — Printed Circuit Board. A fibre glass or resin bonded paper board, onto which components are mounted. Connection between components are made by tracks of copper on the back of the board, to which the components are soldered.

PNP — A particular structure of transistor (Positive, Negative Positive).

PSU — Power Supply Unit. A device for supplying the voltage to power a circuit can be anything from a battery to a unit which will convert the 'mains' to the required voltage for the circuit.

RAIL — A wire in a circuit (or line on a circuit diagram) which carries current to or from the power unit.

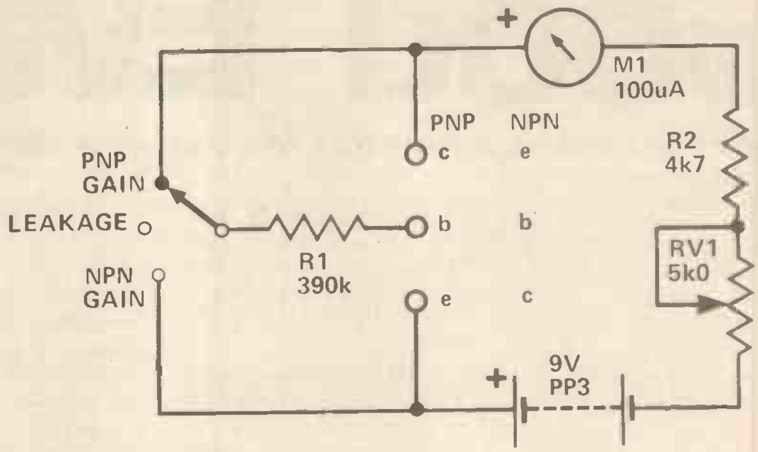
RMS — Root Mean Square. The 'average' voltage of an AC waveform is zero over time (equal positive and negative cycles cancel each other out), the RMS power, voltage or current is a meaningful average, and is defined it to be the value of DC power, voltage or current which has the same heating effect in a resistor as the AC power (voltage or current).

SUPPLY — This is the battery or power unit which provides the electricity to power a circuit.

TRANSIENT — A sudden change (almost instantaneous) of the level of a signal.

Short Circuits

TRANSISTOR TESTER



The cheapest way of building up a stock of transistors is to purchase "bargain bags" from component stores. The main drawback is that you have no idea what characteristics the devices will have, if indeed they have any characteristics at all! Usually between 10% and 30% of the devices will be useless, the remainder will be out of tolerance and not suitable for commercial use — but perfect for use by the experimenter.

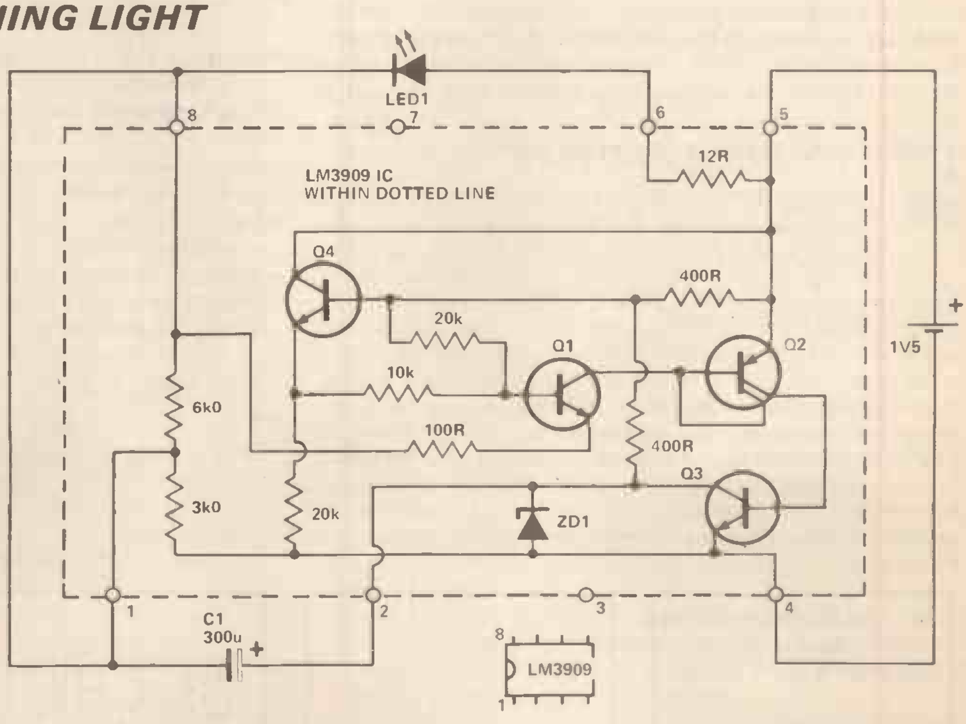
With the aid of this transistor tester you will be able to sort transistors for gain and leakage characteristics, these being the most important for the majority of applications.

Transistor leakage is the current passing between the collector and emitter when no base bias is applied. Gain of a transistor is the ratio of base current to collector current. To avoid complex switching only one socket is used for the testing of devices — NPN and PNP types are inserted in opposite ways to test them. By comparing the meter deflections caused by good quality transistors and surplus types, an evaluation of the characteristics of any particular device can be made — high gain, low gain, high leakage, low leakage, etc. Germanium transistors (such as OC71s) will register much higher leakage than more modern silicon types (BC108s, etc.). If no reading is given for either gain or leakage the transistor is open circuit internally and useless. R2 and RV1 are included to protect the meter movement if the device under test is short circuited internally — again a useless device.

As well as acting as a transistor tester, the unit can be used to check diodes and measure resistance. Diodes inserted between the collector and emitter points will register little or no current one way round, the other way round they should cause high current to be registered. To measure resistance, connect the emitter and collector sockets together and adjust RV1 to give full scale deflection on the meter. Then the meter scale can be marked to coincide with the readings from a selection of known resistor values, connected across the emitter and collector terminals.

Another use for the circuit is for checking PP3 batteries: short the emitter to collector terminal and plug battery in to replace the normal one: No deflection or not full scale deflection, means that the battery is on its last legs. Electrolytic capacitors, when connected across the emitter and collector terminals (making sure positive is to the PNP emitter socket), will produce a 'kick' of the pointer — falling as the capacitor charges up. With practice, an estimate of actual capacitance can be made — no 'kick' means the component is open-circuit, no fall back means the component is short circuited.

LOW-POWER FLASHING LIGHT



Most integrated circuits, in fact most electronic circuits, are designed to operate with power supplies in the range 4V5 to 40V. It is quite rare to find battery-operated equipment fitted with indicator lamps, due to the unacceptable current drain. Even light emitting diodes (LEDs), which use up very little current (usually 10 to 20mA), are not used all *that* often. At very low voltages (below 2V) an LED will not even illuminate!

National Semiconductor have produced an integrated circuit to be used specifically for flashing an LED, even operating at voltages as low as 1V1, with an average current consumption orders of magnitude below that of an LED on its own.

The circuit achieves it's very low current consumption in two ways. Firstly the LED is only illuminated 1% of the time, and only transistor Q4 is turned on for the rest of the time — drawing a current of only 50uA while on. The 300u capacitor determines the flash rate by charging up via the two 400R resistors and the 3k0 resistor. Q1 and Q2 are turned off until the voltage at the positive end of C1 reaches about 1V0. The exact voltage is determined by the junction voltage drop of Q1 and Q4 plus the voltage divider across Q4's base and emitter.

When the voltage at pin 1 is 1V0 more negative than the positive supply (pin 5), Q1 starts to turn on. This in turn switches on Q2 and Q3. The circuit then supplies a high current pulse to the LED. Q3 is a medium-power transistor that can handle 100mA of current, and rapidly brings pin 2 to a voltage close to zero volts. As the capacitor has a charge it makes terminal 1 (the negative end of the capacitor) go below supply zero. At this point in the cycle the cathode of the LED is at a higher potential than supply positive; and the current that flows through the LED is limited by the 12R resistor between pins 5 and 6. The cycle then repeats itself.

Good Evans

Gary Evans takes a monthly look at new developments in the field of electronics.

ONE OF THE best things about being involved with electronics is that there's always something new to play with — did I say one of the best things? Well most of the time yes, but I can remember some occasions when I greeted the latest innovation of the IC manufacturers with something other than an ode to joy.

A few years ago, for example, I had spent many long nights risking life, limb and liquidity putting together a TV game. The beast was built on 4 or 5 circuit boards, used hundreds of components, yards of wire, had a vast power supply and never worked. Well it would have worked were it not for the fact that just as I was about to find out why the ball stayed at the centre of the screen, unmoved by man or bat, a certain IC manufacturer brought out a device that did all my game did plus a lot more. To add insult to my injuries the thing was packed in a small plastic case and ran off a battery.

Gone were my visions of saying "oh it was nothing" as I wheeled my monster into a room of admiring people, for now every one could have a TV game. The challenge had gone out of my life.

Not for long though, for I was soon engaged in trying to get the offending IC to produce a pattern on the TV screen that changed in time with a music signal applied to it, something that would have been far more difficult without some of the sections of the game IC.

That's the key to enjoyment of electronics. Look for new applications of the devices that are available and don't worry if someone "steals" your idea or goes one better — there will be something else ready for you to tackle.

OMO WASHES SLOWER

I don't travel on the bus all that much — not because of any illusions of grandeur but because in London a bus offers a means of transport that will, at best, get you nowhere fast. At any rate having made the mistake of getting on a red devil the other day it struck me that one of the reasons that these new One Man Operated (OMO) vehicles are so slow is the number of people who wait until they reach the fare collecting machine before digging into their pockets/handbags for the fare, invariably to discover they do not have the right change. This then means a fight to get to the driver who then has to dish out vast amounts of small change, a process which involves a lot of counting and time. It would seem common sense to have your monies ready for collection, but in practice very few people have common sense.

This view is further backed up by my experiences with the latest bit of plastic sent to me by my bank. Nice idea this, a card with a magnetic stripe down the back of it — feed it into the mouth of your friendly bank's new machine, key in your personal code number (I'm losing count of how many personal code numbers I have to remember — I'm forever phoning up my credit card — why can't we please have the same number for all these "security" things) and out slides lots of nice cash. If you can find a machine that's working, its likely to have a line of people waiting to use it. Most of these I'm sure only want to play a tune on the dispenser and the others manage to get their cards stuck in the thing. Some will even treat the entry of their code as a game of Mastermind, the machine giving them clues as to how near the number they can get in three tries.

LUNCHTIME FAMINE

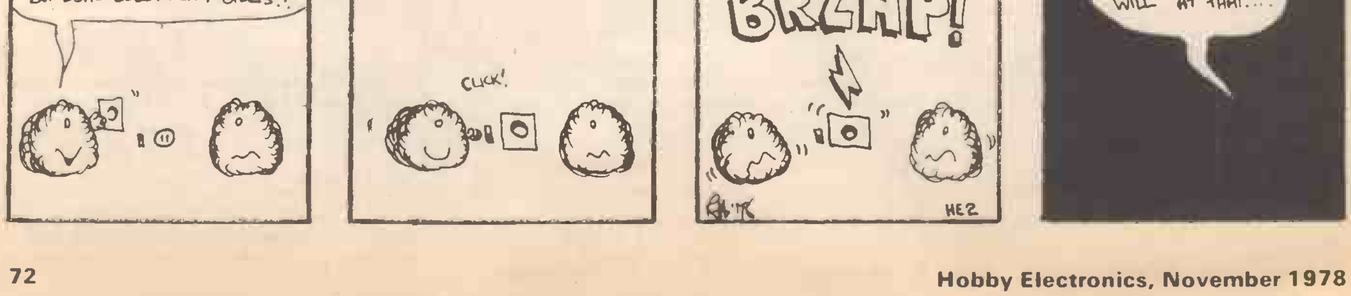
The famine of tellers at lunch time when everyone uses the bank (but they've got to eat haven't they) was one reason for the machines initial attraction. The thing has speeded up my withdrawals, for with everyone playing with the machine I can go to the head of the line in the bank and chat to my favourite teller.

I came across a nice example of lateral thinking the other day when I went to see ARC at Watford, the town not the football club. ARC stands for Automatic Revenus Controls and the company make, amongst other things, coin collection machines for sale all over the world. The machine needs some standard by which it can recognise the various coins it is to accept. Many electronic designers would probably use some form of complicated semiconductor memory to "program" the coins characteristics into the machine. This has a number of disadvantages including the fact that if it's necessary to change the range of coins which the machine is to accept the factory must prepare new programs, thus slowing down the change-over.

ARC's solution is beautifully simple. They duplicate the detecting system that the coins fed to the machine pass through (this works on a magnetic principle) on a "reference" board and simply glue the coin to be accepted to this duplicate detector. If the signals from these two detectors match, the coin is OK. To change the range of coins, unglue those in situ and replace with the new values.

How's that for British ingenuity?

HE



Make sure you don't miss your copy of HE

This is the first issue of Hobby Electronics and we don't know how you, the reader, will react to it. Frankly it's not too hard to sell the first number of any new title, people are curious. What matters more to us is that you like it enough to get No 2, 3 and so on.

If we've converted you with No 1, you'll want to ensure yourself a regular copy. you can do this in two ways, place a regular order with your newsagent or take out a postal subscription. If you opt for the sub, please fill out the coupon below.

To: Subscriptions
Hobby Electronics,
25-27 Oxford Street,
London W1R 1RF

I would like a postal subscription to HE starting with the ...... issue. I enclose payment (£6.50 for UK and Eire, £7.50 elsewhere, surface mail, £11.50 air mail).

Name ....

Address ....

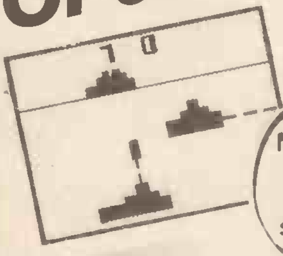
....

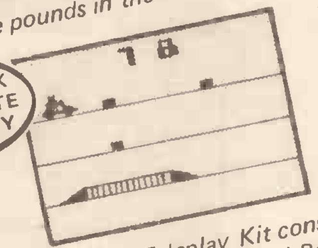
....

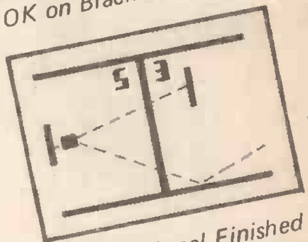
Teleplay presents the PROGRAMAGAME of all time!

TELEPLAY have produced a new product of easy to assemble cartridge games, for you and all your family, that will not go out of date. Just ADD each new cartridge, as it becomes available, and your colour video centre will be up to date the Teleplay way. You will save pounds in the long run. Works OK on Black and White TV.

EX-STOCK IMMEDIATE DELIVERY





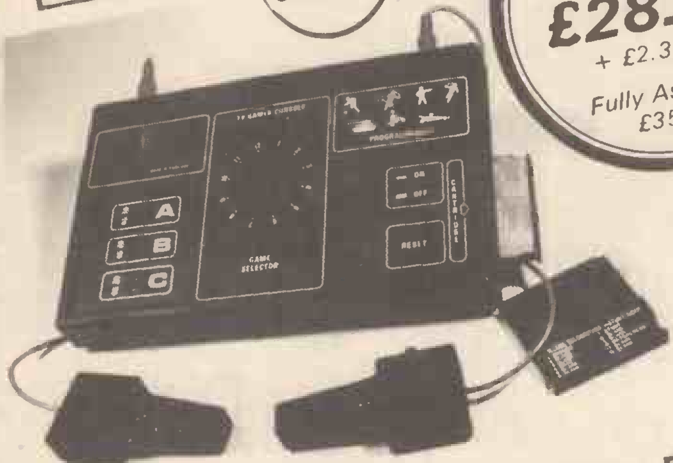


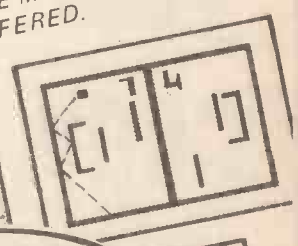
Money back if not satisfied

We offer all this to you for ONLY **£28.95** + £2.36 VAT

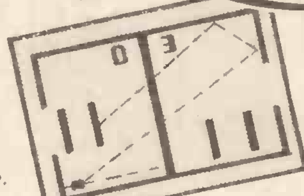
Fully Assembled £35.95

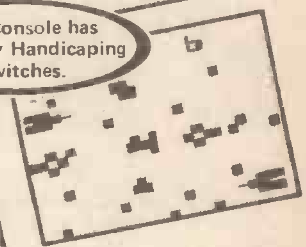
The Teleplay Kit consists of a Professional Finished Inject Moulded Box – Joystick Hand Controls – one cartridge which consists of 10 games – Football, Tennis, Solo Squash (1 & 2 players), Hockey, Basketball (1 & 2 players), Shoot etc. Mains Adaptor. All holes are pre-drilled – No Special equipment required. You'll be surprised how easy it is to assemble this professional kit! Instruction Manual supplied separately at 0.45p. TELEPLAY GIVES YOU TWICE THE FUN BUILDING AND PLAYING THE MOST PROFESSIONAL TV GAME KIT EVER OFFERED.



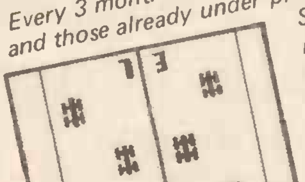


Main Console has 3 Facility Handicaping Switches.





Every 3 months a NEW game will become available to you and those already under production include Submarines, Space War, Wipe Out and many more. The price of these will vary from £12 to £19 depending upon the complexity of the game.



Additional cartridges NOW available include:

Stunt Cycle – 4 games – Cartridges and Hand Controls – £14.95 + £1.14 VAT.
Tank Battle – Cartridge and Hand Controls – £18.95 + £1.56 VAT
Road Race – 2 games – Cartridge – Controls already with basic kit – **£12.95** + £1.08 VAT

Fully assembled add £3.05

Cartridges come complete with printed case and easy to follow assembly instructions.

REALISTIC SOUND EFFECTS

All parts fully guaranteed.

Electrical knowledge is not a necessity to assemble this project – just simple soldering.

Cheques and Postal Orders to be made payable to **TELEPLAY**; send your order (No Stamp Needed) to Teleplay, Freepost, Barnet, EN5 2BR or telephone your order quoting your Barclaycard or Access number. Queries and Technical Advice offered either by phone or by calling at our shop.

BARCLAYCARD VISA

SHOP OPEN – 10am to 7pm – Monday to Saturday
CLOSE TO NEW BARNET BR STATION – MOORGATE LINE

We welcome Access

Watch this page each month for new cartridges, as they become available.

All prices include Postage.

Compare our prices with similar products in the big stores, which cost well over £100.

teleplay

EUROPE'S LARGEST STOCKIST OF TV GAME COMPONENTS.

14 Station Road, New Barnet, Herts EN5 1QW Tel: 01-440 7033/01-441 2922